



ARMY SERVICE FORCES  
FIFTH SERVICE COMMAND

**UROLOGICAL CONFERENCE**  
AND  
**SYMPOSIUM**  
ON THE  
**PARALYZED PATIENT**

DOCUMENT SECTION



11 - 12 MAY 1945

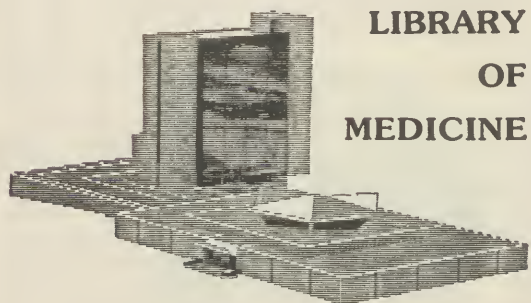
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PROGRAM

11 May 1945

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11 MAY 1945

Morning Session

Call to Order - Lt Colonel David H. Poer, Presiding.

The first meeting of the Fifth Service Command Urological Conference will now come to order. It is our pleasure to have our Commanding Officer, Colonel Cook, address us at this time.

COLONEL COOK: It is indeed a pleasure to have you with us today at this Urological Conference and Symposium on the Paralyzed Patient sponsored by the Fifth Service Command. I want to welcome you to the Newton D. Baker General Hospital and hope that we have a nice and profitable meeting. I want to introduce at this time General Fred W. Rankin, Colonel E. A. Noyes and welcome all the officers and guests with us today.

GENERAL F. W. RANKIN: Colonel Cook and guests. I suppose I speak in the place of The Surgeon General who is not here to speak for himself, but who will be here this afternoon. I am sure he would say that, if he were here now, he would be highly pleased with the program which has been prepared for you and with the turnout. I have certainly looked forward with a great deal of pleasure myself to the program, particularly the treatment and care of the paralyzed patients in the Army. I think it has been one of the outstanding accomplishments. I know of no other place where it has been accomplished in a better way than the Fifth Service Command. I look forward to the program with a great deal of pleasure.

COLONEL POER: Because of the fact that General Kirk and other guests will arrive later in the morning we have attempted to shift some items on the program in order to allow for a visit to the Urological Clinic and any wards you care to visit. We will go ahead with the program at this time with a break at about 0930 and reconvene here at 1100. There has also been a request that the arrangement of the papers be changed and I wonder if Captain Lipshutz would be ready to go ahead at this time.

The first paper will be "Non-Specific Urethritis and Prostatitis in the Army" by Captain Harold Lipshutz of Wakeman General Hospital.

CAPTAIN HAROLD LIPSHUTZ: It can probably safely be stated that the greatest number of cases seen in the Urological clinics of the Army General Hospitals are comprised of non-specific urethritis and prostatitis. These are plebeian diseases, yet of vital importance from the military point of view.

Wherein lies the importance to the Army?

First - Loss of manpower hours from active military duty by the loss of the soldier's time during the repeated and often unnecessary prolongation of attendance at Out-Patient Clinics.

Second - Loss of manpower hours from active military duty through the unnecessary hospitalization of cases that can, and should, be treated through the Out-Patient Clinic.

Third - Loss of manpower hours from active military duty by the unnecessary prolongation of types of therapy where no results are being attained.

Fourth - Lastly, the loss of efficiency. Here, with certainty, it might be said that any individual affected with a urethral discharge, and in this respect a soldier is no different than any other individual, is a temporarily demoralized individual, whose main thoughts are constantly centered on the disease of that part of the body, the normal health of which is so essential in the lives of each one of us.

(Slide to Illustrate)

What are some of the contributory factors involved in the above four premises?



First - The lack of awareness, which exists in both civilian medical practice and in the Army, that the common underlying etiological factor in persistent and recurrent non-specific urethritis is not a chronically infected prostate, but chronic infection of the glands of Littre, situated along the floor of the urethra. (Slide to illustrate). Every acute infection of the urethra is accomplished in varying degree by involvement of these glandular structures. In many cases of urethritis, dependent on the severity of the inflammatory process, obstruction of these glands of Littre is a common sequel, and quite often, small, minute abscesses are present during the acute phase of the infection. Fibrous scarring of the urethral mucosa about the small glandular duct is the pathological explanation of the chronic residual retention of pus. Unfortunately, many cases of recurrent urethritis are kept under constant and repeated prostatic massage when at no time has a sound been passed to evaluate the pathology present in the urethra proper, nor, in many cases has therapy been applied to the diseased areas directly involved.

Second - Sulfonamides and penicillin will cure the diseases under discussion in many cases. However, there is a large percentage of cases, in which both sulfonamides and penicillin have absolutely no effect. Now, with both penicillin and sulfonamide therapy, result of therapy should be rapid and objective, quickly discerned. Yet, despite this, many cases, under hospitalization for clinical care, are continued under either or both of these forms of therapy when failure to obtain a quick beneficial effect has resulted.

Parenthetically, it might be stated that we all know that the prostatic and urethral chronic infection may or may not be secondary to antecedent gonococcal infection; but we do not know that some virus, filtrable or otherwise is not at fault in some of these cases. This possibility must be kept in mind in those cases, resistant to the more recent methods of therapy just described.

What plan of therapy, in the Army, might be offered for the treatment of the diseases under discussion? The following plan is respectfully offered, having proven of value to the author in the therapy of non-specific urethritis and prostatitis in the Army.

First - No soldier affected with chronic prostatitis or chronic urethritis should be hospitalized in a General Hospital, but should be treated on an Out-Patient status, unless there is a flare-up with an acute complication such as prostatic abscess, severe hemorrhagic urethritis or acute epididymitis.

Second - And extremely important, a brief, stern and concise statement to the patient of the necessity of absolute cooperation in an attempt to avoid unnecessary sexual excitement. It has been of help to the author to ask the soldier whether he would rub an acutely inflamed eye or a severe boil on his arm, and what would happen if he did. Psychologically, this question has a good effect.

Third - The insistence on the dietary avoidance of all spices and alcohol.

Fourth - The management of the acute non-specific urethritis, and the acute phase of recurrent infection of the urethra, varies with the preference of the individual urologist, who will usually employ that method of therapy which has given him the best results. The author's plan is to avoid any local treatment or instrumentation of the urethra during the acute flare-up. The guide for local therapy is the presence of two glasses of clear urine in a two glass specimen study, the presence of no shreds being no contra-indication to active local therapy.

Fifth - ORAL THERAPY. Here sulfonamides receive prior employment. All cases are given an initial course of therapy with either sulfadiazine or sulfathiazole, but the use of the drug is not continued longer than 96 hours if improvement is not marked. The plan has been to give 15 grains, 4 times daily for a period of 5 to 7 days, and then  $7\frac{1}{2}$  grains, 4 times daily for an additional 7 to 14 days, if improvement is continuous and no contra-indication arises.

When the sulfa drugs have failed to produce a rapid improvement two (2) drugs have been of extreme value to the author over a period of years in the handling of non-specific urethritis, two old drugs, with the use of which many of you will probably not be in agreement. The two drugs are Oil of Sandalwood and methenamine; the latter in the form of a commercial preparation called Hexalet, produced by Biedel and Company. Oil of Sandalwood is given in doses of



minims XV., 3 times daily after meals, with a glass of water. (Caution should be given that a backache of no consequence is apt to be produced). The latter drug, Hexalet, has been used because of the greater tolerance shown by the digestive system, and because of the contained self-acidifier, sulfa-salicylic acid. Therapeutic use of either of these drugs is prolonged beyond a period of one week only when improvement is continuous. If one of these drugs does not help, then the other is used.

Sixth - Penicillin. Since this therapeutic agent is needed for more serious cases, its use should be reserved for those cases which are disabling, and when all other treatments have failed.

Seventh - LOCAL THERAPY is necessary in a high percentage of cases in order to completely cure the infection present and to prevent recurrences. The treatment employed consists of antiseptic applications and astringents to the urethra, and sounding. Here, it has always been of value to the author to avoid the use of any strong medication. The preference has been for many years to make use of either  $\frac{1}{2}\%$  aqueous Mercurochrome,  $\frac{1}{2}\%$  Neo-silvol, or 5% silver protein such as Solargentum applied throughout the urethral tract, under reducing pressure by injecting the solution through a Keyes-Ultzman cannula, injecting the solution as the instrument is being withdrawn, in order to avoid undue pressure in the region of the verumontanum. The most important medication, and one that almost of necessity must be used because of its astringent action, to finally clear up resistant urethritis is Silver Nitrate, the percent of solution is not to exceed 2%, the optimal probably being 1%.

Eight - Sounding. Herein lies the secret to prevention of recurrences. Unless severely scarred, contracted areas about the glands of Littre along the urethral floor are stretched, and free drainage is given to the badly, chronically infected glands, recurrence is usually the rule, rather than the exception. Sounding should be at weekly intervals for at least six (6) treatments, with as large a sound as can be passed, but not beyond the size of a #32 French.

Ninth - Concerning prostatic infection. In civilian life, foci of infection should be searched for and cleaned up. In the Army, this is not always too practical, especially as concerns tonsillectomy on a large scale, because of the loss of manpower hours time to the Army. Abscessed teeth certainly should be removed. For the purpose of the Army, prostatic massage need not be continued forever. When, after a reasonable period of prostatic massage, sulfonamides or other oral therapy, and possibly a small amount of Penicillin, there remain a moderate quantity of WBC's in the prostatic fluid per high power field of the microscope, the soldier should be discharged, if he is symptom-free, with no evidence of urethritis. (Slides to illustrate point in discussion by review of cases)

The following slides contain brief resumes of the histories of cases of non-specific urethritis that have been cleared up by employment of the regime just outlined. Most of the cases, chosen from a large series of similar ones, are cases in which Penicillin and sulfa therapy have failed to effect a cure--or at least have failed to keep the soldier on duty, and not mentally disturbed.

#### SUMMARY

The prime purpose of treatment in the Army, of both chronic prostatitis and non-specific urethritis, is directed to keeping the soldier on full, active, military duty, free of any demoralizing influence. Hospitalization in a hospital ward should be kept to a minimum, limited in prostatic disease to the severe, acute parenchymatous prostatitis and prostatic abscess; in urethritis, to the severe, hemorrhagic type, or that accompanied with an acute complication such as acute epididymitis or conjunctivitis.

#### CASE #1 (Sulfa-Resistant Urethritis)

Appeared at WGH GU Clinic 20 February 45

Diagnosis: N.S. Urethritis, Secondary to Acute Gonorrhea (July 1944)

Duration and type prior treatment: FOUR MONTHS, including sulfadiazine.

Therapy employed at WGH GU Clinic: oil of Santali orally, 1% silver nitrate locally two times, sounding one time (Palpable glands of Littre).

Date G.U. clearance: 13 March 45. No symptoms, no Signs.

Duration of urological therapy WGH GU Clinic: 22 DAYS

CASE #9 (N.S. Urethritis Resistant to Penicillin)

Appeared at WGH GU Clinic: 10 April 45

Diagnosis: N.C. Urethritis.

Duration and Type prior treatment: ONE MONTH, including 200,000 units of Penicillin

Type of Therapy employed at WGH GU Clinic: Oil of Santali orally.

Date G. U. clearance: 17 April 45. No symptoms, no Signs.

Duration of urological therapy WGH GU Clinic. 7 DAYS

CASE #2 (Chronic Urethritis Arrested by Oral Therapy)

Appeared at WGH GU Clinic: 30 January 45

Diagnosis: N. S. Urethritis, Secondary to Acute Gonorrhea (August 44)

Duration and type prior treatment: FIVE MONTHS, including 800,000 units of Penicillin, 1 course sulfathiazole, 1 course sulfadiazine.

Therapy employed at WGH GU Clinic: Oil of Santali orally.

Date G. U. clearance: 15 February 45. No symptoms, no Signs.

Duration of Urological therapy at WGH GU Clinic: 16 DAYS

CASE #11 (N.S. Urethritis, Recurrent, Hemorrhagic, Severe, Complicated by Acute Conjunctivitis)

Appeared at WGH GU Clinic: 6 February 45

Diagnosis: N.S. Urethritis, Hemorrhagic, Recurrent.

Duration and type prior treatment: EIGHT DAYS; present attack no treatment. (Previous attack July to August 44 cured by sulfadiazine orally and Argyrol locally)

Type of therapy employed WGH GU Clinic: Oil of Santali, Hexalet, Sulfadiazine orally, (improvement noticed with use of latter two drugs);  $\frac{1}{2}\%$  Mercurochrome,  $\frac{1}{2}\%$  Silver Nitrate, 1% Silver Nitrate, locally, sounding, (palpable glands of Littre).

Date G.U. Clearance: Patient still under treatment. No symptoms.

CASE #12. (N.S. Urethritis, Hemorrhagic, Antero-Posterior, Severe, Resistant to Penicillin and Sulfathiazole).

Appeared at WGH GU Clinic: 14 February 45.

Diagnosis: N.S. Urethritis, Acute Hemorrhagic, Severe.

Duration and type prior treatment: NINE WEEKS, including 600,000 units of Penicillin, 5-day course of Sulfathiazole. Type of therapy employed WGH GU Clinic: Oil of Santali orally,  $\frac{1}{2}\%$  Mercurochrome and 1% Silver Nitrate locally.

Date G.U. Clearance: 13 March 45. No Symptoms. No signs.

Duration of urological therapy WGH GU Clinic: 28 DAYS



CASE #13 (N.S. Urethritis, Chronic, Cleared up by Local Treatment)

Appeared at WGH Clinic: 17 January 45.

Diagnosis: N.S. Urethritis, Chronic.

Duration and type prior treatment: TWO YEARS, type prior treatment unknown.

Type of therapy employed WGH GU Clinic: Urethral Sounding, 1% Silver Nitrate locally (Palpable glands of Littre).

Date of G.U. Clearance: 15 February 45. No Symptoms, few shreds in urine.

Duration of Urological Therapy WGH GU Clinic: 29 DAYS

CASE #8 (N.S. Urethritis Secondary to Acute Gonorrhea, Resistant to Penicillin and Sulfathiazole)

Appeared WGH GU Clinic: 10 October 44

Diagnosis: N.S. Urethritis, Secondary to Gonorrhea.

Duration and type prior treatment: TWO MONTHS, including 500,000 units of Penicillin, a 10-day course of Sulfathiazole.

Type of Therapy employed at WGH GU Clinic: Oil of Santali orally.

Date G.U. Clearance: 7 November 44. No symptoms, no signs.

Duration urological therapy WGH GU Clinic. 14 DAYS

CASE #3 (N.S. Urethritis Resistant to Penicillin)

Appeared WGH GU Clinic: 20 December 44

Diagnosis: N.S. Urethritis.

Duration and type prior treatment: TWO MONTHS, including 600,000 units of Penicillin, one 5-day course of Sulfathiazole.

Type of Therapy employed at WGH GU Clinic: Hexalet orally, instillation 1% silver nitrate, 1 time.

Date G.U. Clearance: 1 January 45. No Symptoms, No Signs.

Duration urological therapy at WGH GU Clinic. 12 DAYS

CASE #10 (N.S. Urethritis Resistant to Sulfa)

Appeared at WGH GU Clinic: 5 January 45

Diagnosis: N.S. Urethritis, Chronic, recurrent.

Duration and type prior treatment: SIX YEARS, numerous courses of sulfa drugs.

Type of therapy employed WGH GU Clinic: Hexalet and Oil of Santali orally.

Date G.U. Clearance given: 10 February 45. No symptoms, no signs.

Duration of urological therapy WGH GU Clinic: 36 DAYS

CASE # 5. (N.S. Urethritis Resistant to Penicillin and Sulfa)

Appeared WGH GU Clinic: 5 December 44.

Diagnosis: N.S. Urethritis.

Duration and type prior treatment: TWO MONTHS, including 100,000 units of Penicillin, 1 course of Sulfa.

Type of therapy employed WGH GU Clinic: Hexalet orally, 1% Silver Nitrate into the urethra, sounding one time (Palpable glands of Littre).

Date G.U. Clearance given: 12 January 45. No Symptoms, No Signs. (Except few shreds in urine).

Duration of urological therapy at WGH GU Clinic: 28 DAYS

CASE #4 (N.S. Urethritis, Resistant to Sulfadiazine)

Appeared at WGH GU Clinic: 20 February 45

Diagnosis: N.S. Urethritis

Duration and type prior treatment: TWO MONTHS, including 6-day course of Sulfadiazine.

Type therapy employed at WGH: Oil of Santali orally.

Date G.U. Clearance: 13 March 45. No Symptoms. No signs.

Duration of urological therapy WGH GU Clinic: 22 DAYS

LT COLONEL POER: Capt Lipshutz' paper is now open for discussion.

MAJOR JOSEPH J ROTH: Gentlemen. I have had the opportunity for several months to see a great number of these cases at Camp Campbell. At that time, we had two divisions of troops, including some detachment troops from the 2nd Army. We ran a GU Clinic three times a week. There was never a time while those troops were there that we saw less than fifty or sixty cases of non-specific urethritis and prostatitis at each clinic. So you can readily see what the loss of manpower is. I am in perfect agreement with Captain Lipshutz that these patients should not be hospitalized because they do not ordinarily get daily treatment, except drugs by mouth. Furthermore, we do not want to totally disable them.

I have found that these cases come under three categories: (1) Residual prostatitis and urethritis resulting from acute gonorrhea. We find a fair number of cases that have a chronic urethral discharge, giving the appearance of gonorrhea and some of these last a long time. (2) We find those cases due to bad sex hygiene. These cases usually start with a simple, ordinary congestive type of prostatitis where the patient complains of mild frequency and occasional burning, and on examination we find nothing. These cases, if allowed to go on, become secondarily infected. (3) We have the third group that we can divide into two classes - where foci of infection exist elsewhere in the body or the cause unknown.

There is just one drug that I would like to add to those mentioned by Capt Lipshutz. In these urethral cases, the azo dyes, such as pyridium or perenium have helped where other drugs have failed. Dr Walters of New Orleans recommends them and I have tried them in several cases. They have helped in a great number of cases. Occasionally, where the urethritis is ultra-resistant and apparently will respond to nothing, and we have seen such cases, I think it would be advisable to fulgurate the glands of Littre endoscopically.

LT COLONEL POER: Any further discussion?

CAPTAIN B P PETROFF: I would like to ask Captain Lipshutz where he gets sandalwood oil?

CAPTAIN LIPSHUTZ: I am glad that both of these subjects were brought up. About the azo dyes. Azo dyes are very fine. In urology we all know that you cannot depend on one drug, and the azo dyes are good. It is a problem to get these drugs in the Army. I am certain that I can make the statement that we have saved alot of manpower hours by the method that we have employed in our clinic.



We have been getting the sandalwood oil through our Medical Supply Officer on a non-standard drug requisition. I am sorry to say that recently the use of both oil of sandalwood and Hexalet was turned down absolutely by the Office of The Surgeon General in Washington. We will probably have to resort to the use of the Methenamine, and hope the results will be good. I know that I can safely say that we have saved many manpower hours for the Army and are willing to have our records checked to prove this.

COLONEL C. S. BECK: This has been a very important problem in our hospitals. Almost every General Hospital has a number of these patients. I think the policy of treating these patients on an outpatient status is to be recommended.

LT COLONEL POIR: I will now introduce the next speaker, Major Abel J. Leader, who is speaking on "Tuberculous Epididymitis".

MAJOR A. J. LEADER: The declining incidence of genital tuberculosis for the last two or three decades has paralleled that of other forms of the disease. For this, credit is due to a prophylactic consciousness that has resulted in improved hygienic standards, the tuberculin testing of cattle and dairy herds, and early recognition and prompt and vigorous treatment of the disease when it does occur.

Despite this we still see enough of genital tuberculosis to know that it is not a rarity, and the problems it presents are as perplexing as they were 20 or 30 years ago.

The epididymis is now accepted as the primary focus of tuberculous disease in the genital tract by most urologists, consequently tuberculous epididymitis is almost synonymous with genital tuberculosis since it is almost always associated with tuberculosis of the seminal vesicles and the prostate. Hugh Young and his followers, who are in the minority, spoke of the disease as tuberculosis of the seminal tract, since it is their view that the early lesions are in the seminal vesicles and in most cases the epididymis is secondarily involved. Young therefore advocates removal of the seminal vesicles, portions of the prostate when involved, the vas deferens, and the epididymis. When the disease is unilateral he believes that the opposite side does not often become involved following this treatment. Barney, whose views are shared by most urologists, believes that the disease usually begins first in the epididymis and that the lesions in the seminal vesicles and prostate improve and become quiescent when the epididymis and the distal portions of the vas are excised. In light of results and burden of proof rests with the proponents of the Young theory.

Over 70 percent of the cases of epididymal tuberculosis are encountered in the age group which is most common to the army - that of 20 to 40 years. With more than ten million men in the services, it appears almost as though most new cases of epididymitis might be expected to come to our attention sooner or later. In spite of the gravity and chronicity of the disease, these patients can be helped, and it is believed that a restatement of what we know concerning the operative and non-operative methods of treatment will be helpful. Some of these problems require discussion from the Army standpoint. What are we going to do with these patients after they have been operated? Should these patients be carried in isolation and how far should we go in isolating them? What should we do with these patients after their wounds heal? What should be the Army policy with respect to the treatment of sinuses developing postoperatively, and should hospitalization be continued during this period?

First, it is known that genital tuberculosis is rarely, if ever, a primary disease. The mediastinal and broncho-pulmonary nodes, the lungs, the kidneys, or the bones are actively involved in most cases, and in some several active foci may be recognized. Consequently the prognosis depends largely on the general condition of the patient and the extensiveness and activity of the tubercular lesions elsewhere. Epididymal tuberculosis is a local manifestation of a systemic disease and a thorough work-up of the patient generally is always indicated before any surgery is contemplated. One must be especially alert for a possible renal focus. Braasch in 1920 reviewed a series of 234 cases of renal tuberculosis and found that 171, or 73 per cent of the cases, had genital infection. In this connection too, Bumpus points out that dysuria, usually described as one of the symptoms of genital tuberculosis, is in reality a symptom of renal involvement, for he was able to show that renal tuberculosis existed in 72 of 79 cases of genital tuberculosis presenting this symptom. Where a unilateral renal focus is



demonstrable in conjunction with genital tuberculosis, nephrectomy is always indicated as a prelude to surgery on the epididymis, for it eradicates the reservoir which otherwise continues to feed infection into the genital tract. Most authorities advise against performing nephrectomy and epididymovasectomy at the same operation, and the latter is generally left for a later time.

As to whether surgery should be done for genital tuberculosis in the Army, it is our opinion that it is justified in every case in which the condition is considered to have developed in line of duty. It is true that once the diagnosis is made the soldier with epididymal tuberculosis has no further value to the service, and on theoretical grounds, the surgery should properly be left to the Veterans' Administration Facility, but as with traumatic paraplegias, cases of genital tuberculosis require "stabilization" and a good start is made toward stabilizing these patients by the surgical elimination of the active focus, whether it is in the kidney or the epididymis, or both. The only possible contraindication we are apt to encounter in the Army is the presence of a ~~non-comitant~~ bilateral renal tuberculosis, in which case surgery is out of the question and medical management is all that is possible. In civilian practice far-advanced pulmonary or bone lesions and well advanced tuberculosis of the entire male genital tract on both sides constitute further contraindications of surgery. Bilateral tubercular epididymitis, even with moderately advanced involvement of the prostate and seminal vesicles, is operable, for it has been conclusively shown that in a relatively large number of such cases the condition of the prostate and seminal vesicles will improve following surgery.

Epididymovasectomy in the manner described by Cabot appears to be the procedure of choice in surgery of the tuberculous epididymis. This operation includes a careful dissection of the epididymis from the testicle, preserving the testicle, and removing the vas deferens well above the internal ring. The operation is most satisfactorily done under spinal anesthesia. Because of the almost constant involvement of the vas, this is separated from the cord up to the external ring. The vas is doubly clamped with curved Kelly clamps, divided a short distance above the epididymis and the cut ends are carbolyzed. The point of the clamp holding the upper end is guided into the external ring and carefully pushed along the canal until the tip of the forceps lies at the internal ring. The handle of the clamp is then depressed and an incision about half an inch long is made directly over the tip of the clamp, which is thus exposed. The end of the vas thus exposed is grasped by another hemostat and the original clamp removed. The vas is then gently withdrawn and by continuous gentle traction and finger dissection as much of the vas as possible is withdrawn. It is then clamped deep in the wound, ligated, divided, its end carbolyzed, and it is permitted to drop back to the depths of the wound. The inguinal wound is closed with a single catgut stitch in the aponeurosis and another of silk or dermal closes the skin. Conservatism is the general rule with respect to the testicle unless its blood supply has been compromised in the dissection or unless the involvement of the testicle by tuberculosis is at all extensive. In such cases the testicle should be removed. Small superficial areas of involvement may be curetted and carbolyzed with excellent chance of preserving the testicle for its valuable internal secretions. Bleeding is carefully controlled and a small rubber tissue drain inserted to the surface of the testicle, to be removed in three days. The wound in the scrotum is closed with interrupted mattress sutures of dermal, following which a snug suspensory dressing applied.

The foregoing method offers excellent chance for primary healing. This is rarely the case when the epididymis is marsupialized as advocated by Keyes. As to the treatment of the uninvolved epididymis, although it has been shown that 45 to 64 percent of these will become involved subsequently, usually within a year, here too the treatment should be conservative. Ligation of the uninvolved vas does not prevent extension of the process, this being due to extension via the reticulated lymphatics or recurrent hematogenous dissemination. Those who favor bilateral epididymovasectomy argue that azoospermia occurs in 85 percent of all cases of epididymal tuberculosis, even when one side is clinically uninvolved. Bilateral epididymovasectomy seems justified where azoospermia is shown to exist since this usually means that the apparently uninvolved vas is already occluded by a tuberculous lesion that cannot be palpated.

Now that we have operated on our patient, what plans are we going to make for him both as regards to his convalescence from surgery and for the immediate future? It must be emphasized that surgery represents only a start in treatment and that these patients must continue hospitalization for at least six months and preferably a year following surgery. During this time they must be kept in bed and given the benefit of heliotherapy, high vitamin, high caloric diet, ultraviolet therapy and the best medical and nursing care. A sad experience of



ours, in which an apparently healed incision broke down and commenced to drain immediately after the patient had inadvertently been given a furlough, brought home to us how important it is to divorce ourselves from sentiment in these cases. Regardless of how long a soldier has served overseas before he is sent to us, and how long it has been since he has seen his family, it is our duty to the patient to keep him at rest, in the hospital and in bed.

The formation of chronic draining sinuses is one of the major complications of surgery for genital tuberculosis. These sinuses usually result within a few weeks after surgery when as a result of abscess formation the line of incision breaks down more or less completely resulting in the formation of a deep wound with profuse drainage which may continue for years. For such cases heliotherapy and local irradiation with the air cooled mercury vapor quartz lamp are invaluable in promoting early healing, especially if the interval of time between the formation of the sinuses and initiation of this form of treatment is not prolonged. Wang has demonstrated that the closure of these sinuses can be effected in about 4 months. This is in contrast to the much longer periods required in most of the cases not given the benefit of ultraviolet therapy. He emphasizes the importance of regularity in treatments and of early treatment in obtaining the best results.

The treatment of genital tuberculosis is a long-term proposition and one to which the Veterans' Hospital is better adapted than is the Army General Hospital. It has been stated that these patients require a minimum of 6 to 12 months of bed rest, heliotherapy, ultraviolet therapy, good food and excellent medical and nursing care. It is our opinion that such cases should be transferred to a Veterans' Facility without delay following recovery from surgery. Where the case is complicated by sinus formation shortly after surgery, we believe that discharge should not be effected prior to closure of the wound by ultraviolet therapy. Overseas cases which have been operated on but in which sinuses have developed subsequent to operation should be carefully evaluated in an Army General Hospital for possible renal involvement. If this work-up is negative the patient should be discharged from the service and sent to the Veterans' Hospital for further treatment. Current directives make an exception of officers and enlisted men of the first three grades, as well as enlisted men of long service. These patients are eligible for transfer to the Fitzsimmons General Hospital.

Most General Hospitals do not have tubercular wards, since the incidence of cases does not warrant this. The question as to whether or not patients suffering with genital tuberculosis should be isolated is one that deserves some consideration. While it is known that most of the purulent material discharged by the chronic tuberculous sinus does not contain the acid fast organism, still in a sufficiently high percentage of cases the discharge is infectious. The danger from the careless handling of dressings saturated by the discharge lies in the possibility that the pus may dry out and the organisms inhaled in sufficient concentration by those previously non-infected to start up the disease. For this reason we believe that care should be taken that all dressings should be immediately burned, and that the clothing of the patient which has been soiled by the discharges should be specially treated. Inasmuch as these patients require constant bed rest, it is generally advisable to keep them in a separate room where such precautions as given above can be most easily followed throughout. Of course if active open lesions in the lungs are demonstrable, the usual precautions as are taken with all cases with pulmonary tuberculosis should be strictly observed.

A few words may be added concerning the use of tuberculin in the treatment of genital tuberculosis. Opinion is divided as to its value, but some authorities feel that it is helpful but that it is by no means the most important factor in producing results.

In closing, it appears from all information available to us that early surgery and prolonged postoperative treatment as we have outlined offers the best hope for the successful treatment of genital tuberculosis.

LT COLONEL POER: The paper of Major Leader is now open for discussion.

CAPTAIN C. O. MILLER: I just wish to congratulate Major Leader on his splendid paper and presentation. There are two points that I think should be driven home.

I think these patients do markedly improve following surgery. We had a patient sent in from the 12th General Hospital in the Pacific. This boy had

a tuberculous epididymitis that had been removed. The pathologist stated at this time that there was marked caseation of this organ and that he had marked involvement of the right lobe and right seminal vesicle. He was draining from an old sinus in the scrotum and I could not find any involvement of the prostate, clinically. Urine was repeatedly examined, I.V. check plates taken and to date we have not been able to find any evidence of tuberculosis in this boy. He is now getting well. I also feel that this patient should not be left on the ward as it is impossible to teach these patients to properly handle their dressing if they are having a lot of discharge. There is always the danger that they will cause infection of other patients.

LT COLONEL POER: There are several visiting civilian doctors to whom we wish to extend the privileges of the floor. Are there any further comments?

COLONEL C. S. BECK: Several of these patients with tuberculous epididymitis are on the Urological Service of practically every General Hospital that I have visited. How should they be placed on isolation precautions or should such precautions be disregarded? Major Leader recommends a modified isolation regime, in that, each patient should be placed in a side room off the ward and that the dressings be burned. I think these precautions are to be recommended. These patients are discharged from the Army after the wound is healed and drainage is stopped. I question the advisability of placing a drain in the wound at the time of operation. A drain might allow the entrance of secondary infection and this in the presence of tuberculosis might become chronic.

DR. W. H. TOULSON: In regard to this question of surgery in tuberculosis, a few years ago there was a symposium connected with a meeting of the American College of Surgeons, and it was generally agreed that tuberculosis of the urinary tract was a manifestation of the general disease and that all of these cases should have, if possible, presurgical therapy in the up-building of the patient. Everyone seemed to feel that the pathology would fibrose the lesion, or bring it a very rapid fulminating condition, and would prove in a short time whether this patient had a surgical chance or not. You don't see much tuberculosis and I understand that in the service you see little or none. I am reminded of a patient I had some time ago. This patient of mine had a unilateral renal tuberculosis, had complete genital tuberculosis, and after about six months of sanatorium care he gained thirty pounds in weight, his resistance improved tremendously and we went ahead with a successful nephrectomy. He was an intelligent young lawyer, and the question came up about the risk if married. He did that very successfully. He has a lovely, healthy daughter. There has been no evidence of any recurrence. In closing, I would like to say that I think we ought to regard surgical tuberculosis as a local manifestation of a generalized infection.

MAJOR J. J. JOELSON: In regard to drainage, as a general principle, it is wrong to drain tuberculous lesions. In the scrotum, however, it is safer to put in a drain for the first twenty-four hours to avoid the danger of getting a hematoma. Our cases of tuberculous epididymitis at Crile General Hospital have been kept in bed for some time before operation in order to give the sub-acute inflammatory reaction a chance to subside.

MAJOR G. C. FRATHER: The discussion so far and the presentation of the problem has made the diagnosis appear fairly simple. As Dr. Toulson and I were just saying privately, we sometimes have difficulty in regard to diagnosis if no scrotal fistula exists. The individual who has a thickened epididymis may represent a chronic non-tuberculous infection or a chronic tubercular one. This raises the question as to how far one is to go in the military to prove or disprove the diagnosis of tuberculosis. Let us assume that we have ruled out the upper urinary tract and that the prostate is not abnormal to palpation, but the thickened and irregular epididymis is obvious. I would like to ask those who determine policy, which is rarely the urologists themselves, as to what the military wishes us to do and how far we are to go in this matter. If one is able to make a probable clinical diagnosis do they wish us to pursue a period of bed rest in a named general hospital, is the patient to be transferred to Fitzsimmons General Hospital with simply the clinical diagnosis, or should epididymectomy be performed. Dr. Toulson and I are in agreement as to certain ways of handling these cases, namely by non-surgical measures if possible, but others may think differently. We usually receive instructions, and I would like to ask what those instructions are in regard to this problem.



GENERAL F. W. RANKIN: I do not know anything about policies of this type except common sense. Major Prather has made it seem a lot harder than it may be. As a matter of fact, we do not have much of this in the Army that is hard to decide. In officers and the first three grades of enlisted men with background of long service, that is already decided for you. They go to Fitzsimmons and other places. I should think that the best way to handle this man would be like a sick man. Give him the maximum hospital benefits that you can give him. If you can diagnose the case, which is, after all, your problem, Major Prather, I think we ought to treat him like a civilian patient. Give him the best care we can give him to the maximum.

CAPTAIN J. H. SEMANS: Recently we have demonstrated calcification of the epididymes by X-ray. This was confirmed by x-rays of the epididymes removed at operation. The microscopic diagnosis was tuberculous epididymitis. X-rays of the scrotum in epididymitis are of diagnostic value, if calcification is demonstrated. Photographs of the X-ray of the scrotum and of the epididymes themselves are attached.

MAJOR A. J. LEADER: The whole subject of tuberculous epididymitis is highly controversial in almost every respect as regards management. I have attempted to outline what represents the preponderantly authoritative opinion as to how these cases should be managed. Even those who insist on exclusive medical management of this problem have some good points on their side. A report from Fitzsimmons General Hospital recently indicates that there is some doubt as to the place of surgery in tuberculous epididymitis, but at the same time, its author points out that he has never seen a healed caseous lesion in the genital tract, regardless of the method of treatment. I think that continued study of the problem is necessary, but meanwhile as General Rankin points out, we can continue to treat these cases as good common sense and good judgment dictate.

LT COLONEL POER: Meeting adjourned to permit visit to Ward 108 and Urological Clinic. Reconvened at 1100. Addressed by General N. T. Kirk, Surgeon General.

GENERAL N. T. KIRK: I am delighted that this conference has been called here at Newton D. Baker on the problem of paraplegia. This hospital, I know has been doing a splendid job in rehabilitating this type of patient, as well as doing excellent work in the care of other patients transferred here for definitive care. It is paramount that the paraplegic be brought as nearly to normal as is possible by means known today, before he is discharged from the service and turned over to his own care or to that of the Veterans Administration.

If there is a medical group in America who can accomplish this, it is you who are here today wearing the insignia of the Medical Corps. I am sure much will come out of this conference to clarify the job that faces us in meeting our target. I hope that through a proper circular after your deliberations here, we will be able to standardize the method of handling the paraplegic in all of our neurosurgical centers. This is teamwork.

I am proud of the job that you men are doing here and of what you who are guests here today are doing in your own hospitals in other service commands. From the civilian medical profession who have visited our hospitals I have heard what a grand job you are doing and what splendid teamwork they see everywhere they go. This makes me still more proud of what you are doing.

I thank you.

GENERAL S. U. MARIETTA: It is a great pleasure to be here at this conference, but I have nothing to say.

GENERAL R. W. BLISS: I am very glad to be here today but like General Marietta, I have nothing to say.

LT COLONEL POER: The next paper will be "Urinary Calculi in Recumbent Patients" by Major James J. Joelson of Grille General Hospital.

MAJOR J. J. JOELSON: The occurrence of urinary calculi has long been recognized as a complication of prolonged recumbency, but only recently has it been forcibly brought to our attention as a fairly common and serious complication in soldiers returned from overseas because of extensive fractures of the long bones or serious abdominal injuries. In a relatively short period of seven months we have en-



countered thirty-one such cases at Crile General Hospital, and these cases form the basis for this clinical study of the condition and the statistical data.

In twenty-six of these patients the primary cause of the enforced recumbency was a compound complete fracture, usually with osteomyelitis, of one or more long bones of the lower extremity or of the bones of the pelvis (femur - 15 cases, tibia - 7, fibula - 4, pelvic bones - 9). Of the other five patients, one had a compound fracture with osteomyelitis of the scapula and the other 4 had severe injuries to the abdominal viscera which had resulted in prolonged recumbency. The 27 cases of fracture with complicating nephrolithiasis represented 2 percent of all direct orthopedic admissions, and the 15 cases of fracture of the femur complicated by nephrolithiasis represented about 7 percent of all cases of fractured femur admitted during the period of this clinical study.

Eighty-nine percent of these patients were casualties from the European Theater of Operations, indicating that a tropical climate is not necessarily a factor in the formation of renal stones of recumbency.

The shortest period of recumbency in these cases was one month, and the longest was nine months, the average being four months. The shortest period between the initial injury and the onset of urinary symptoms was three months, and the longest was nine months, with an average of four and one-half months.

Twelve of the 31 patients had a single calculus, and 19 had multiple stones. In 23 of the patients the stones were unilateral and in 8 they were bilateral. They varied in size from 2 or 3 mm to 2 cm in diameter.

All of the 31 patients had hematuria, either gross or microscopic but only 13 showed any pus in the urine, and of these only 5 had a serious infection. The pH of the urine before treatment was started varied between 5.5 and 7.5, with an average of 6.5.

The stones were demonstrable by X-ray in 24 cases (about 77 percent). In the other 7 cases the diagnosis was finally proved by the passage of one or more stones.

The analysis of the recovered stones showed them all to be calcium stones; 70 percent were calcium phosphate and 30 percent were calcium oxalate. Seventy-five percent of the phosphatic stones showed also the presence of some oxalate, and 50 percent of the oxalate stones showed traces of phosphate. Only one stone in this series showed a positive test for sulfonamides.

The serum calcium, blood phosphorus and phosphatase (alkaline) were normal in all of the cases studied at Crile General Hospital, but all of these were "old" cases, the initial injury having been received three or more months previously. In one case, which was studied at another hospital and was seen soon after the injury, the serum calcium was found to be elevated and the alkaline phosphatase was up to 17 units (Bodansky).

The Sulkowitch Test for the amount of calcium in the urine was done in 12 cases and found to be definitely elevated in 4 (33 percent), indicating that a hypercalcinuria may persist in some of these patients for more than two months. These four patients had been immobilized for an average interval of five and one-half months at the time the test was done, the shortest period being four months and the longest eight months.

The great majority of our patients were treated conservatively. They were placed on a high fluid intake of at least 4000 cc per day. The acidity of the urine was increased by means of a high acid ash diet, and, if the daily pH determinations indicated it, the diet was augmented with ammonium chloride. Also, these patients were gotten out of bed as soon as this could be safely accomplished, and if this were not possible an effort was made to change their position in bed frequently. Cystoscopy was avoided if possible in the uninfected cases, although cystoscopic manipulations were utilized in those cases which were already infected, or when there were definite indications for this form of treatment. By this general scheme of therapy satisfactory results were obtained in a high percentage of the patients. In one case a most dramatic result of dissolution of the bilateral stones was obtained; in 16 cases the stone or stones were all passed;

4 patients have either passed some of their stones or have shown a decrease in the size of the stones; 2 have shown no improvement and will probably require operation; 5 will undoubtedly require surgical intervention, and 3 have already been operated upon. Solution "G"7 has been used in 4 patients, either through a nephrostomy tube or a two-way ureteral catheter, without any appreciable results.

In this series of cases there were 2 deaths from renal insufficiency and severe pyelonephritis; both of these patients were in very poor condition at the time of their arrival at the hospital and presented other complicating factors. One had only one functioning kidney, and that was filled with innumerable stones and severely infected. The other patient, in addition to the nephrolithiasis and severe pyelonephritis, had a badly fractured pelvis, a cystostomy, a colostomy, and a large recto-urethral fistula.

Although the mechanism of the formation of these stones of recumbency may not be completely or fully understood, many factors are known which undoubtedly play an important role in their production. These factors also point the way to various procedures in the treatment of these cases.

It has been demonstrated that during the first month or two of immobilization a marked hypercalcinuria occurs and that this becomes apparent within the first week.<sup>3</sup> This is the result of withdrawal of calcium from the bones which in turn may be a result of disuse, although the possibility of a more complex disturbance of calcium metabolism must also be considered. In addition to the great increase in the amount of calcium thrown out in the urine there is also an increase in the precipitability of these urinary calcium salts, thereby still further favoring the formation of calculi. It is likely that the various calcium salts (mainly phosphates, but also oxalates and carbonates) precipitate from the urine either as small amorphous masses or small conglomerations of crystals and form as a sediment in the minor calyces and pelves of the kidneys. With the patient flat on his back the calyces are the most dependent part of the upper urinary tract<sup>3</sup>, and, therefore, it is not surprising to find that most of the stones of recumbency are formed in the minor calyces. In a normally active individual these minute "calculi" would not settle here but would most likely be washed out of the urinary tract without causing any symptoms. However, in an immobilized patient they remain in the calyces and gradually increase in size by accretion and the further precipitation of the calcium salts from the saturated urine. The enforced recumbency therefore acts in two ways: first by causing a hypercalcinuria, and secondly by allowing the sediment that forms in the calyces to remain there and increase in size. Another factor which seems to favor the formation and growth of these calculi is the infection which is present with the complication osteomyelitis.

The possibility of sulfonamide crystals as the primary nidus for the formation of these stones must be seriously considered. Soon after his injury large doses of sulfa drugs are apt to be given to the soldier at a time when it is not possible to maintain a large fluid intake. Undoubtedly at this time sulfa crystals may precipitate in the renal pelves and calyces, and such crystals could well be the beginning of larger calcium stones. All of the recovered stones in our series were carefully analyzed for the presence of sulfonamides, but they were found in only one stone and the other stone in the same renal pelvis did not contain any sulfonamide.

The acidity of the urine is another extremely important factor in the formation of these stones. Calcium phosphate, which is present in most of the stones of recumbency, will precipitate in an alkaline urine but will usually remain in solution in an acid urine.

#### Treatment

The treatment of urinary calculi of recumbency can be considered from the viewpoint of the two phases of the disease.

The first phase constitutes the first two months or so of recumbency, during which period there is a hypercalcinuria and an increased precipitability of the calcium. It is during this period that the calculi begin to form, and much can be accomplished at this time by various prophylactic measures to prevent their formation at least inhibit their continued growth. The latter possibility is of great importance, for if the stones do form but can be kept small, the patient will



eventually be able to pass them and thus avoid further renal complications and major surgery.

The second phase of the disease is that in which the stones have already formed and treatment for them must be instituted. It must be remembered, however, that the hypercalciuria may persist during this phase and thus cause a continued increase in the size and number of the stones.

The first phase is a critical period in the patient's course, and it is of vital importance that everything possible be done to avoid the formation of calculi. The complication is not an uncommon one, it is a serious one and is occasionally fatal. Therefore, no effort should be spared to prevent it. The various procedures which will combat the tendency to stone-formation are logical, apparent and relatively simple to carry out.

During the first phase of the condition, the treatment may be outlined as follows:

1. Fluid Intake
2. Diet
  - a. High acid ash or neutral ash
  - b. Elimination of milk
  - c. Elimination of fruit juices
  - d. Vitamins
3. Medication
  - a. Urinary acidifiers
  - b. Urinary antiseptics
4. Movement of the patient
5. Laboratory studies necessary for the proper diagnosis and treatment.

Fluid Intake. Ample fluid intake is essential and it will accomplish several desirable effects if it be kept at a high enough level. A daily intake of 3000 to 4000 cc can be considered minimal, and in febrile patients a still greater intake is desirable. If the patient cannot take sufficient amounts by mouth, they should be supplemented by parenteral methods. This high fluid intake will dilute the urine, thus lowering the concentration of the calcium salts and thereby decreasing their tendency to precipitate. This lessened tendency toward precipitation will not only make the formation of calculi much less likely but will also tend to prevent their continued growth should they form. The diuresis produced will result in physiological lavage of the renal pelves and calyces which will flush out some of the small masses of precipitated calcium salts or other debris which may form. A good fluid intake will also lessen the possibility of a superimposed infection of the kidneys, a complication which frequently results in serious sequelae. Such an infection may not only cause the patient to become critically ill and thus necessitate cystoscopy or some form of operation at a time when such forms of therapy may have decided disadvantages, but it may also cause a very rapid and extensive growth of the stones.

Diet. The diet of these patients is exceedingly important in the prophylaxis and also in the actual treatment of the stones. An effort must be made to keep the urine sufficiently acid, and the hydrogen-ion concentration of the urine should be determined daily in order to make certain that this end is achieved. If the pH of the urine can be kept between 5.2 and 5.4, the calcium phosphate will be kept in solution and will not precipitate.<sup>4</sup> Unfortunately, calcium oxalate will precipitate in either an acid or alkaline urine, but the formation of pure calcium oxalate stones as a result of recumbency is uncommon (15 percent of our cases); furthermore, all the calcium salts are more soluble in an acid urine so that there is a lessened tendency for these stones to form and grow.

The first step in acidifying the urine consists of placing the patient on a high acid ash diet. If, after several days, the pH determinations do not show a satisfactory degree of acidification of the urine, the diet should be augmented by some form of medication, such as ammonium chloride. It must be borne in mind that the high acid ash diet may occasionally cause an increase in the urinary output of calcium and thus produce the same undesirable results as would follow a high calcium intake. It is, therefore, advisable to study the calcium output in the urine before and after the diet has been started, and if a rise occurs the diet should be changed to a neutral ash diet. This is especially important during the first phase of recumbency calculi, since Flocks found that this rise in urine calcium is much more apt to occur in patients who already have a hypercalcinuria.<sup>3</sup> Flocks further suggests that this increase of urinary calcium following the acid ash diet is probably due to an increase in the absorption of calcium by the alimentary tract.<sup>3</sup> If this is so, the proper reduction of calcium in the diet may tend to overcome this undesirable side effect of the acid ash diet. When infection of the urinary tract with one of the urea-splitting organisms is present, the high acid ash diet, with or without acidifying drugs, is contra-indicated. It will fail to make the urine acid, and there is the possibility that it will increase the hypercalcinuria and thus cause the stones to grow even more rapidly in the alkaline urine. The acid regime is also contra-indicated in the presence of poor renal function because acidosis may result.<sup>2</sup>

Milk should be eliminated from the diet, for this food definitely increases the amount of calcium excreted in the urine, and it has been demonstrated that a high calcium diet will double the urinary output of calcium.<sup>3</sup> It is claimed by some that the calcium of the milk is desirable and necessary for the production of good callus formation and proper healing of bone, and the patients are therefore urged to drink large amounts of it. This is not an entirely sound idea, especially in the recumbent patients who are already withdrawing into the circulation large amounts of calcium from the bones which they do not utilize and excrete in the urine. During this period the addition of large amounts of milk to the diet still further increases the hypercalcinuria and the tendency to stone formation. In several of our patients the Sulkowitch Test showed a decrease in the urine calcium after simply withdrawing milk from the diet. It is, therefore, highly desirable that not only milk but all foods with a high calcium content be either eliminated from the diet or kept at a reasonably low level. In some localities the calcium content of the water may be high enough to be taken into consideration and necessitate the use of distilled or soft water.

Another dietary error consists of giving these patients large amounts of fruit juice, since it is believed by some that the contained vitamins are beneficial to proper bone repair. If this be true, the necessary vitamins could easily be given in pill or capsule form and thus the marked alkalinization of the urine by the fruit juices could be avoided. The ingestion of large amounts of both fruit juice and milk results in a highly alkaline urine containing large amounts of calcium, the most perfect combination possible for the formation of renal lithiasis and for the continued and rapid growth of the stones.

The diet should have a high vitamin A content. There is no satisfactory proof that this vitamin does play an important role in preventing the formation of renal calculi, inhibiting their growth or causing them to undergo dissolution. However, the possibility exists that this vitamin does have some beneficial effect in the treatment of urinary calculi and since it can do no harm it may safely be used. If necessary, the intake of this vitamin can be enhanced by pills or capsules. It is important to emphasize that the vitamin A capsules which are standard in the Army Pharmacopeia also contain Vitamin D and therefore should never be used in the treatment of urinary lithiasis. It has been definitely demonstrated that vitamin D, even in moderate doses, will cause an excessive increase in the urinary calcium of these patients.<sup>3</sup>

Medication. Ammonium chloride may be used to further the acidification of the urine if this is not satisfactorily accomplished by the high acid ash diet alone. It should be borne in mind, however, that these acidifying substances may cause an increase in the calcium excretion in the urine. Albright and his co-workers have demonstrated this undesirable effect in their studies of cases of hyperparathyroidism<sup>1</sup> and several other observers warn against the possibility of an increase in the hypercalcinuria with the acid regime.<sup>2,3,5</sup> For this reason the degree of hypercalcinuria should be studied, and this is especially true in the first two months of recumbency when this side effect is more likely to occur.



Sodium acid phosphate and ammonium phosphate have also been recommended as acidifiers but their use has the possible disadvantage of increasing the amount of phosphates in the urine.<sup>2,6</sup>

The various urinary antiseptics are frequently of value in combating the infections of the urinary tract which may complicate the nephrolithiasis. These superimposed infections offer a serious problem in these cases and must be guarded against in every possible way. It is advisable that frequent microscopic examinations of the urine be done so that the infection can be recognized early and proper steps taken. The sulfonamides are probably the most useful drugs in the treatment of these infections. Sulfacetamide shows the greatest solubility in either an acid or alkaline urine and therefore does not form sulfa crystals in the renal pelvis or calyces around which further stones may form. Since it seems to be as efficacious in urinary tract infections as the other sulfonamides, it is to be preferred in these cases. Sulfathiazole is fairly soluble at any pH of the urine but not sufficiently so to prevent the precipitation of crystals. Sulfadiazine and sulfapyridine should be avoided if possible because of their relatively low solubilities, especially in an acid urine.

Our results with penicillin have been disappointing in urinary tract infections even when the causative organism was not a gram-negative bacillus, and Thompson reports only slightly more encouraging results.<sup>8</sup>

Ammonium mandelate may be of value in some cases, although the necessary limitation of fluid intake is most undesirable. Calcium mandelate should not be used because of the large amounts of calcium which are ingested when this drug is taken in proper doses.

Many of the infections are due to urea-splitting organisms, and once these have established a severe infection, it is frequently impossible to eradicate them by any drug.

Some of the cases, especially those with fractured pelvis, are further complicated by the necessary suprapubic cystostomy tube. This frequently has already brought about a severe infection of the bladder by the time the patient reaches the zone of the interior. Every effort must be made in these cases to avoid an ascending infection to the kidneys by proper and continuous attention to the tubes and drainage system.

Movement of the patient, either active or passive, is essential. It has been demonstrated that the urinary calcium is greatly increased and may even be doubled within a few days after recumbency has been instituted. This is especially true in fractures in which large portions of the body must be immobilized. This hypercalcinuria lasts for about two months, following which it usually disappears even though immobilization is maintained, but it may persist. After recumbency ceases, the urinary calcium returns to normal rapidly.<sup>3</sup> It is therefore, apparent that those patients who are completely immobilized should be turned at least once a day, if possible, in an effort to allow the dependent minor calyces to empty themselves of any sedimentary particles which may have collected there. As soon as it can be safely accomplished, these patients should be gotten out of bed and encouraged to take as much active motion as their disability will allow.

Laboratory Studies. Various laboratory investigations are necessary in these cases for the purposes of diagnosis and the proper treatment of the patient. Renal function tests, such as phenolsulfonephthalein and blood nitrogen determinations, are routinely indicated, and further blood chemistry studies of the serum calcium, blood phosphorus and phosphatase (alkaline) should also be done.

The studies of the urine are extremely important. Frequent microscopic examinations must be done in all recumbent patients so that the possible presence of renal stones can be diagnosed early and treatment begun before they have had a chance to become large or numerous. The presence of pus or blood in the urine, even though microscopic, should immediately lead to further investigation of the urinary tract. The continued frequent urinalyses during the course of the disease will indicate whether or not infection has been superimposed. The early diagnosis of this complication is necessary for the proper and effective treatment of the condition. There is a tendency in some of our laboratories not to consider the microscopic examination of the urine as part of the routine urinalysis. It cannot be emphasized too strongly that the microscopic examination of the urine is a most important part of the urinalysis and that it must be done frequently and routinely in all cases of enforced recumbency.



The pH of the urine must also be carefully followed to determine whether the diet and the medication are having the desired effect. It is preferable that this be done on the ward immediately after voiding and thus avoid the delay of transportation to the laboratory, during which time a change in the pH may occur. This can easily be done with the nitrazine paper test which is satisfactory for all practical considerations. The urine to be tested for pH should not be the first morning voiding, for this may be affected by the awakening respirations, nor should it be taken soon after a meal when the alkaline tide is likely to influence the acidity of the urine.

The Sulkowitch Test is a relatively simple procedure which gives a fairly accurate indication of the amount of calcium contained in the urine and may be an aid in determining whether the acid regime is causing an increase in the hypercalcinuria. Where indicated, the more accurate quantitative chemical determination of the urinary calcium can be carried out.

X-ray examinations of the urinary tract are of course indispensable for diagnosis and for following the course of the disease and its response to treatment. Repeated films will indicate whether the stones are increasing, decreasing or remaining stationary and thereby give an excellent index of the results of the therapy; this is probably a more practical test than the tests for an increase in the calcium in the urine. Intravenous pyelography can give much information as to the conditions present in the kidneys and ureters, and this method should replace diagnostic cystoscopy wherever possible.

X-ray film of the urinary tract of all recumbent patients might be considered as a desirable routine procedure, but judging from our results this is probably an expensive and unnecessary method. In 258 consecutive cases of fractures of the lower extremity, routine films of the urinary tract were done. In not one of these was there a calculus demonstrated which had not been suspected because of clinical symptoms of microscopic hematuria. It seems, therefore, that repeated microscopic examinations of the urine will be more helpful than an occasional routine x-ray film in detecting these calculi of recumbency.

The treatment of the second phase of renal calculi of recumbency presents the urologist with many difficult and serious problems. It is in this phase, when the stones have definitely formed, that these patients are usually seen in the zone of the interior. The stones are apt to be multiple, small and scattered throughout the minor calyces - the type of stones which is most difficult to completely remove surgically. Furthermore, various complicating factors are usually present, such as plaster casts, colostomies, cystostomies, and severe fractures with osteomyelitis which require attention. Unless operation is urgently indicated because of ureteral obstruction or severe renal infection, it should be delayed, and the same applies, more or less, to cystoscopy.

These patients should immediately be placed on the therapeutic regime outlined for the first phase and thoroughly studied. Unless there are definite contraindications, they are kept on this treatment for months. During this time the acid urine may completely or partially dissolve some of the stones and many of the stones will be passed spontaneously. Seventeen of our 31 patients have already passed or dissolved all their stones. Four have either passed some of the stones or have shown a definite diminution in the size of the stones so that a satisfactory end result seems likely. These figures indicate that much can be expected from proper conservative treatment and that this form of therapy should be continued as long as there is the slightest chance that it will accomplish any results. In certain cases cystoscopic manipulations or surgical intervention will certainly be indicated and should be used, but only after careful consideration of the problems involved.

Cystoscopy should be avoided if possible in all uninfected cases because the danger of introducing infection into the fertile soil of these urinary tracts is a definite possibility and the superimposed infection makes the condition infinitely more serious. It is not possible to enumerate clear-cut indications and contraindications for either cystoscopy or surgery, for each case will present its own specific problems and much will depend on the surgeon's clinical judgment. In general, it may be said that cystoscopy should be reserved for those cases with definite obstruction of the ureter or pelvis, cases with infection and obstruction, cases in which the ureteral stone seems too large to pass without manipulations, or whenever the symptoms or condition of the patient demand it. Cystoscopy for the use of Solution "G" in uninfected cases is to be condemned, since the results do not warrant the risk of introducing infection.



Surgery should be delayed if possible until conservative treatment has been given an adequate trial and until the patient's general condition is such that surgery can be safely undertaken. Also it is desirable to have had the patient out of bed for some time before operating and thus overcome the hypercalcaemia with its tendency towards reformation of stones. X-ray evidence that the stones have stopped increasing in size or number is reassuring information to have before operation, since it indicates that the chance of recurrence is much less. Occasionally, however, the surgeon's hand will be forced by various conditions or complications which will necessitate surgery before these optimum conditions are obtained. The type of operation to be done will be determined by the conditions present and by the experience and judgment of the surgeon.

#### Summary

1. The results of the study and treatment of 31 cases of renal calculi of recumbency are summarized

2. A regime of therapy for the prophylaxis and for the management of the disease is presented.

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LT COLONEL POER: The next paper will be on "The Non-Surgical Management of Stones" by Major Frank C. Hamm of Wakeman General Hospital

MAJOR F. C. HAMM: The objective of non-surgical management of urinary stone is to achieve the state of perfection, in which formation of all types of urinary stone may be prevented, and to be able to bring about the dissolution or disappearance of stone once it has formed. Although considerable useful information has been accumulated on this subject the final answers to many of our problems remain obscure.

It is difficult to estimate the incidence of urinary stone in the Army. The more serious cases, particularly of a chronic and non-urgent nature will gravitate naturally to the General Hospitals in the Interior, so that a study of this group may be given an inaccurate picture. However, judging from experience in this type of hospital, the incidence of stone is relatively high. In a recent survey carried out within the last three months we were able to collect sixty-two examples of stone formations, the majority of these stones having formed in patients with two months or more of recumbency for various reasons, principally orthopedic cases. The severity of these stones varied from renal colic, accompanied by gross or microscopic hematuria followed by the passage of a small calculus, to instances of bilateral renal stone of the most serious type.



At the present time, indications for non-surgical management are found in the prevention of stone formation in that group of patients who must be confined to bed or immobilized for any considerable period, (The incidence of stone formation in this group has been reported as varying from five to ten percent), or in the prevention of recurrence in a patient known to have formed a stone, but who has been relieved of the calculus, either by surgery or their own painful efforts. The recurrence of stone in this group has been reported as varying from ten to forty percent.

Attempts to dissolve a stone once formed are indicated in those cases in which surgery is contraindicated, or expected to carry unusual hazards. As an example, a small calculus, sand or gravel, that may be left behind following the surgical removal of multiple renal calculi; or a recurrence of a calculus in a kidney that has been operated upon previously, and technical difficulties increase the risk of operation.

The calculus is only the manifestation of some underlying pathologic process that must be eliminated to prevent a new calculus from forming.

All stones, either passed or recovered at operation, are analyzed as the future management depends on their chemical consistency. Most of the stones will be found to fall into the following groups:

1. Cysteine
2. Uric acid and Sodium Urate
3. Calcium Oxylate
4. Calcium Carbonates
5. Calcium Phosphates

The calculus may present almost any combination of these constituents. A varying amount of magnesium may be found in combination with calcium phosphates and carbonates. When the calculus is not available for chemical analysis it is difficult, and at times impossible, to determine its chemical consistency. However, there may be clues. For example, in the cysteine stones there is usually a profusion of cysteine crystals in the urine, a "cysteinuria". The pure stones are relatively non-opaque and show poorly in the roentgenogram. There may be a secondary deposit of calcium salts as shown in illustration No 1. They are relatively rare and only one case appears in this series. They result from faulty metabolism of the amino acids. Cysteine is one of the amino acids essential to proper growth. There is a familial tendency shown in this type of stone formation. Pure cysteine stones are soluble in alkaline solution, and have been dissolved by increasing the pH of the urine.

Uric acid stones are the result of faulty purine metabolism. Like the cysteine stones they are relatively less radio opaque than those containing greater quantities of calcium. They are frequently found in a sterile acid urine. Their recurrence may be reduced by a purine free diet, (sweet breads, liver, kidney, etc.), and increasing the pH of the urine by giving an alkaline ash diet.

Calcium oxylate stones may present a typical mulberry appearance. Their surface is studded with nodules or spines. The appearance in the roentgenogram may be characteristic. They usually form in an acid, or occasionally in a neutral urine, and are usually free of infection. Illustration No 2, represents a calcium oxylate stone. There is no known method of dissolving this type of stone. Its prevention depends on elimination of oxylate producing foods, and decreasing the pH of urine with an acid ash diet.

The alkaline phosphatic stones constitute the greater portion of calculi. The calcium and magnesium phosphates and carbonates are those more commonly found. They are usually formed in the urine whose reaction is neutral or on the alkaline side. They may be present without infection, but approximately one-half of the cases are produced or at least are found to be associated with an infection of the urea-splitting organisms, Staphylococci, Proteus Ammonae, and some gram negative bacilli.



There is no single cause for stone formation. Some of the factors known or suspected to be involved are: Dehydration. Increased stone formation has been observed in arid countries. It is important in this connection to stress the output of urine rather than the intake. Enormous amounts of fluids may be lost through the lungs, perspiration, or various complications such as diarrhea or vomiting. It is only the water that reaches the kidneys that dilutes the urine. Nadeau, and others, have observed several cases in which they attribute the disappearance of large renal stones to the drinking of a gallon of distilled water daily for a year or more. Maintaining a dilute urine is of importance in the prevention of stone, particularly when it is known that there is an increased excretion of some product of metabolism in the urine.

Diet is undoubtedly a factor in stone formation. In practically all stone forming areas the diet is deficient. The disappearance of urinary stone in childhood from England and France during the early Nineteenth Century is probably accounted for by improved diet and sanitation. A deficient diet at the present time is one that is lacking principally in animal protein. Some observers attribute the increased stone formation in this group to an absence of "acid ash" producing substances. We have observed a disturbance in protein metabolism in our severe stone cases with a rapid loss of proteins, a disturbance of the albumine globulin ration to such an extent that I am convinced there is much more to this whole problem than the acid ash factor. It has been indicated that various stones form more rapidly when the pH of the urine is favorable for the precipitation of their various ingredients. Diet is useful in controlling the pH of the urine. The acid ash diet is an effective method of reducing the urinary pH and it has been widely advocated in the prevention of alkaline stones that form in a sterile urine. However, it cannot be relied upon to the exclusion of other factors. The following illustrations show the progress made in cases of recumbency while on the acid ash high vitamin diet. These are both paralyzed patients with severe spinal lesions. The importance of stasis and recumbency cannot be minimized in these two cases. Flocks, and others, have observed an increase in the excretion of calcium following use of the acid ash diet. Several instances of actual increase in the size of the stone have been reported by other observers. However, there is not complete agreement as to the value of this diet.

The importance of vitamin A has been stressed. Experimental studies made by Higgins, and others, indicate that rats will form urinary stones in a high percentage of instances when deprived of vitamin A. These studies indicate that the formation of stones is dependent upon a metaplasia and desquamation of the renal epithelium. Tests for vitamin A deficiency have been made by the ophthalmologist using the Biophotometer. However, there is some disagreement in regard to the efficacy of this method of appraisal, and recently Jewett, and others, have studied eighty-seven cases of urinary stone without finding evidence of vitamin deficiency. Any diet should include adequate vitamins, but too much reliance should not be placed on this factor alone.

The elimination of foci of infection should be carried out. Rosenau's experiments in which he isolated a streptococcus from certain calculus cases and subsequently implanted these strains into the pulp of dogs teeth resulted in the formation of urinary stones in the formation of urinary stones in five out of six animals.

Stasis is a factor of known importance. Calcium plaques, as described by Randall, collections of crystals, and cellular debris, are all potential nuclei of stone formation. Under favorable circumstances, these nuclei will pass in the urinary stream, but in the presence of stasis they will be retained. Stasis may be present in the form of an anatomic lesion, such as an abnormally long, or bottle neck lower calyze, or uretero-pelvic obstruction. Too, recumbency may deprive the kidney of its upright position. The human urinary apparatus is not designed to function properly when the patient lies on his back for prolonged periods. Illustration No. IV. The pelves are higher than the remainder of the kidneys when the patient lies on his back. The Stryker frame is valuable in frequent rotation of immobilized patients, and also provides free drainage. There is a vent in the frame which permits the suprapubic tube to project through the mattress when the patient is lying on his abdomen.

Hyperparathyroidism is a definite factor in stone formation, but only in a small percentage of cases. It may be suspected in instances where there is an increase in the urinary calcium output and where a disproportion between the blood calcium and the blood phosphorous exists. The finding of a characteristic bone lesion is, of course, conclusive. A single calcium and phosphorous blood determination is not sufficient, but the patient must be placed on a calcium free diet for three days. If at the end of this time the urine shows more than a moderate trace of calcium, hyperparathyroidism may be suspected.



be suspected.

Urinary infection is an important cause of stone. The combination of stasis and infection is formidable. The former must always be dealt with before infection can be controlled. The urea-splitting group consisting principally of the Staphylococci, Proteus Ammonae, and gram negative bacilli, have the unhappy property of splitting urea into ammonia and CO<sub>2</sub>. The liberation of ammonia produces a very alkaline urine, in which alkaline phosphatic types of stones are readily formed. The proteus is probably the most difficult organism to dispose of. Creevy has pointed out that this organism may be introduced by instrumentation or surgery. We are reluctant to catharize the ureter in cases of uninfected renal stone, and prefer to obtain visualization by means of the intravenous urogram.

Suby and Albright have worked with various organic acids to determine their relative ability to dissolve the alkaline calculi. They also carried out observations on the rabbit bladder to determine the degree of irritation produced by various combinations. Solution G was the first satisfactory product of their efforts. The formula is:

Citric Acid (monohydrate)	32.3 gms
Magnesium Oxide (anhydrous)	3.8 gms
Sodium Carbonate (anhydrous)	4.4 gms
Distilled Water Q.S.A.D.	1000 cc.
pH 4	

This solution should have a pH of 4. It is important to check this factor at regular intervals. To date, we have used solution G in a total of seven cases. Five of which were renal stones, and two were bladder stones. Two of the seven cases are under treatment at the present time and insufficient time has elapsed to form an opinion as to the result.

One renal stone was present in a case of recumbency with paralysis. The introduction of the solution through the urethral catheter produced temporary improvement in the appearance of the shadow, but the patient's general condition was poor and the treatment was discontinued after about two weeks. There has been an increase in the size of the calculus since. In two cases in which small stones remained after surgical removal of large phosphatic stones, G solution was used through an indwelling ureteral catheter by a continuous drip method. In these two soldiers the irrigation had to be discontinued after a few days because of severe pain, fever, nausea, and vomiting. No improvement was noted in the size of the renal shadows by x-rays. In one case of multiple small phosphatic bladder calculi prompt disappearance was noted following irrigation of the bladder four times daily. In the remaining case of kidney stone, the irrigation through an indwelling ureteral catheter had to be discontinued on account of pain before any improvement could be observed. Out of five cases, one with multiple small stones in the bladder, obtained complete dissolution of their stones.

The failures reported are not entirely the fault of the solution. It is wise to leave a nephrostomy tube in the kidney following operation so that irrigation can be made through it in case sand or fragments remain. The solution may be introduced through an indwelling catheter and allowed to drain out the nephrostomy opening. Albright, Hamer and Mertz, recommend intermittent injection of the solution through a syringe instead of any type of continuous irrigation, particularly when an indwelling ureteral catheter is used. This is intended to gently force the solution around the calculus. It is also apparent that the treatment could not be carried out long enough in the four renal stone cases due to intolerance to the solution. A great deal of patience and care is required to carry some of these patients through two or three months of treatment.

Other difficulties have been described in the dissolution of renal stones. The calculus may be covered with a layer of insoluble organic material which is impervious to the organic acids. Keyser, has used solutions containing enzymes (urease) in an attempt to digest this covering. In a recent communication he expresses his results as not being encouraging. Urease has not been used in any of our cases. It is difficult to sterilize the enzymes and the possibility of introducing infection into the kidney is serious. In some of the cases reported, however, there appears to be a partial dissolution of the stones resulting.

A less irritating solution has been recommended by Suby and Albright, Solution M.

Citric Acid	32.35 gms
Sodium Carbonate (anhydrous)	8.84 gms
Magnesium Oxide	3.84 gms
Distilled Water Q.S.A.D.	1000 cc

This solution has a pH of 4.5. It requires a longer period to dissolve stones using solution M, than it does with solution G. At the present time we have two patients under treatment using this solution.

### CONCLUSIONS

The various methods of non-surgical treatment of urinary stone are of value principally in the prevention of stone formation. Once a calculus has formed and has obtained sufficient size to be of clinical importance, its removal is accomplished best by surgery. The disposal of urinary stones, either by dietary measures, or any of the dissolving solutions, should be reserved for only those cases in which surgery is contraindicated. Our experience to date, while limited, has not been encouraging with stone dissolving agent Solution G, due principally to the irritation of the solution, and to the discomfort of the treatment imposed by the long period requires, especially with the indwelling ureteral catheter method.

### FOR PREVENTION OF STONE

The following procedures may be safely recommended:

1. Increased fluid output, a minimum of 2500 cc each twenty-four hours. This would probably require an average intake of about 4 liters.
2. A high caloric, high vitamin diet should be given. The pH of the urine should be checked so that the diet can be regulated to prevent the urine from becoming neutral or alkaline. The routine use of acid ash diet is not recommended at the present time.
3. Eradication of foci of infection, urinary.
4. Stasis. Surgical treatment is required for anatomic obstructions. Stasis of immobilization and recumbency must be corrected by getting these patients moving earlier. An erect position, either sitting or standing, should be stressed. Those patients immobilized by casts and apparatus should be turned on a Stryker Frame. Turning a patient every two hours is not enough.
5. Urinary infections are watched by urinalysis once a week.
6. Hyperparathyroidism. Recurrent stone cases should have urinary calcium determinations following a three day calcium free diet.
7. In instances where stones have already formed, attempts at dissolution should be attempted only in cases where surgery is contraindicated. It should be given discontinuously, and preferably through a nephrostomy tube. The use of enzymes (urease) is not recommended.

The application of these principles has greatly reduced the recurrence of stone, and in an occasional instance has been credited with the dissolution or disappearance of the stone.

LT COLONEL POER: These papers are now open for discussion.

DR. W. H. TOULSON: I have some slides that I would like to show. I want to discuss just one angle of this stone situation. The stones that seem to be most troublesome are located in the lower end of the ureter, will not pass spontaneously, they become larger, cause damage and infection both to the ureter and the kidney of the affected side. In some instances dense strictures occur in front of these stones that make ureteral dilatation by means of a bougie or catheter impossible. It is with this type of stone that I would like to concern by discussion. It is well known that a normal ureter implanted in another position in the bladder usually offers no problem, but in this infected



and dilated type of ureter where the blood supply is poor, attention must be paid to the details of implanting the ureter. The operation that I want to present is useful in situations of this character. We have had occasion to use this operation successfully only six times. With these slides I will try to demonstrate it.

Slide I - In the lower left ureter we see the stone impacted.

Slide II - Here is the pyelogram that shows the beginning pyonephrosis and the dilated ureter behind the stone. An effort was made to dilate this ureter without success so our problem was either to take the kidney out or reimplant the ureter for bladder drainage.

Slides III and IV - Here are two slides that demonstrate the method of this operation.

Slide V - Here is another stone impacted in about the same location. This patient had a proteus infection which we could never get rid of. He had a very high pH of the urine in spite of diets and drugs. Within a year after the operation the urine slowly went over to the acid side and the infection cleared, and what is more important the stones stopped forming. This patient has been in excellent health now for about three years postoperatively.

MAJOR J. J. ROTH: I am sure that we all are grateful to both Major Joelson and Major Hamm for the enlightenment they have given us on the subject of stones since it has become a major problem in the Army. Within a period of approximately two months we have received at Fletcher General Hospital about fourteen cases of stones of recumbency from the orthopedic service.

In connection with this subject I should like to show some x-ray films of some interesting and unusual types of stones in recumbency. I have never seen this type of case in civilian practice. The first is the case of a young man about 23 years old with a fracture of the femur. He had been in bed for approximately six months. He had no urinary symptoms whatsoever, but in routine check of urine, about which the orthopedic department has been very conscientious, RBC and WBC were found. A flat x-ray plate and intravenous pyelogram showed a column of sedimentary stones in the right ureter. This was impacted in the lower third of the ureter causing urinary obstruction and marked diminution of function of the right kidney. Fortunately, the patient passed these crystals of sedimentary calculi spontaneously. Following this the kidney function returned promptly, and since the patient is now ambulatory recurrence is not likely.

The second case is that of a young man who had a fracture of the femure and a fracture of the shoulder, and who also had been recumbent for from five to six months. He was uretically asymptomatic until he was allowed out of bed whereupon he developed severe left renal colic. In spite of sedation, the colic continued. The flat KUB showed an impact of sedimentary stones in the lower third of the left ureter, the column, as you see, extending from the bladder upwards for about  $4\frac{1}{2}$ ". Because of the continued colic, which no sedation would alleviate, cystoscopy was done but catheter could not be passed above the column as shown in this second film. Accordingly we continued to treat him conservatively without results. He continued to have colic and a rise in temperature up to  $103^{\circ}$  accompanied by chills. A second cystoscopy was then done and a #5 ureteral catheter was passed up to the left kidney pelvis with great difficulty and left in situ. The urinary drip was markedly hydronephritic. However, he continued to have severe colic without any drop in temperature and it was felt that the column of stones would have to be removed. Accordingly, we felt that if we could remove the bottom of the column, the rest of the sediment would pass spontaneously. This was done cystoscopically and was successful. We obtained 320 mm of gravel. In addition, patient had bilateral renal calculi and accordingly patient was placed on a high acid ash diet with great quantities of liquid and the last x-ray showed the kidneys are free from calculi. The sediment showed calcium phosphate and calcium carbonate. Since this patient is now ambulatory we feel that recurrence is not likely.

However, these cases must be observed carefully. These two cases are shown in order to bring attention to the manifold types and possibility of stone of recumbency and in our experience we find ourselves in complete agreement with the opinions of both Major Hamm and Major Joelson.

MAJOR A. J. LEADER: There is very little that can be added to Major Joelson's excellent presentation on the problems of stone formation in recumbent patients. I do believe, however, that one phase of the problem will bear the emphasis of repetition. Prophylaxis is probably the most important consideration in these cases, and I believe that a program of prophylactic management in recumbent patients should be both clearly defined and generally adopted.

Earlier, the complacency of the orthopedic surgeons in connection with stone formation was disturbing, but later with the accumulation of more and more orthopedic cases which were complicated by stone formation and in whom the urologic problems assumed paramount importance, it was gratifying to note in them the development of a "urologic consciousness" which has been very helpful. A fortuitous circumstance has brought me closer to this problem than has probably been true of the experience of most urologists. With the influx of a large number of patients on the orthopedic service about two months ago there developed at Fletcher an acute shortage of orthopedic ward officers, and at the same time an excess of general surgeons, internists, pediatricians, and even urologists. The result was that many medical officers suddenly found themselves on the orthopedic service, and I was one of them. Fortunately, I was assigned to the femur wards where I had charge of about 70 or 80 recumbency cases. It was interesting to observe how many of these patients had abnormal urinary findings, and how common was the occurrence of kidney and ureteral colics and hematuria. It came to the point where I would subconsciously keep my fingers crossed every time we had to take a patient out of plaster, since the onset of symptoms usually occurred following cessation of immobilization. I learned too that while on the urologic service we had been seeing only the relatively more severe cases, and that for those persons in whom the urinary symptoms that had developed with ambulation had been mild and of short duration, no GU consultations had been requested.

In a survey of 576 unselected orthopedic patients at Fletcher, our preliminary figures indicate that of these 212 had abnormal urinary findings. One hundred and fifty cases showed only the presence of a microscopic pyuria, while 62 others showed the presence of various combinations of pus, blood, casts and albumin. It is true that a microscopic pyuria is more common to many other diseases than to calculosis, but we have had several instances in which pyuria was the only manifestation of existing stone diseases, and so we cannot completely ignore this figure.

As major Joelson has pointed out, and Flocks and others before him, there is a "critical period" in the development of stones of recumbency. This is the two months immediately following immobilization. It has been shown that a hypercalcinuria exists for the first sixty days or so after immobilization starts.

Because of the time lag between the first immobilization and the time we see these patients in the general hospitals in the zone of Interior, we do not have control of the patient during the so-called "critical period". It usually takes about two or three months between the time the patient is injured and his hospitalization in the United States. Therefore, the prophylactic program during this early period becomes a responsibility of the lower echelons of medical evacuation such as the field and the evacuation hospitals. Here hypercalcinuria, stasis, and alkalization of the urine can be effectively combatted by a regime which involves the ingestion of large quantities of water, usually not less than four liters a day.

This acts to keep the urine diluted, to keep more of the calcium in solution than would be the case in a more concentrated urine and to aid in the flushing of the kidney as pointed out by Major Joelson. Stasis can be effectively combatted by the simple expedient of turning the patients from the dorsal to the ventral recumbent position for one hour periods at least every two hours. It is worthwhile to point out that a neutral ash and not a high acid ash diet is advised during the first two months of immobilization because it has been shown that the use of the latter results in an increase in the hypercalcinuria. I think that a good point to make here is that by ordinary standards we may think that when a recumbent patient gets 2500 cc. of fluid per day he is getting enough, but actually because of the hypercalcinuria a relative dehydration exists which requires an intake of at least 1500 cc more in order to effectively aid in elimination of the calcium which otherwise might be precipitated. Just a few more points with respect to the prophylactic management of these cases in



the "critical period". Fruit juices, which we are so fond of ordering for our patients, have an alkaline residue which adversely effects the pH of the urine and their use should be prohibited. The use of milk should also be discouraged because it too merely increases the amount of calcium which must be excreted by the kidney, which is already pouring out increased amounts.

As regards to management of recumbent patients in the general hospital in the zone of interior, the same principles must be followed through. Now, however, because there is no longer a hypercalcinuria, a high acid ash diet is advisable since keeping the urine acid and dilute is our objective. Fluid intake must be carefully watched and at least 4000 cc taken daily. Frequent change of position, and ambulation at the earliest possible time are necessary. The patient in a hip spica must be turned at very frequent intervals and if in traction, as much free movement of the unimmobilized parts of the body as is possible must be encouraged. Urines should be carefully checked at least at weekly intervals for all patients and more frequently where abnormal constituents are found. Instrumentation and cystoscopic examinations are generally contraindicated because of the danger of added infection, but there are some occasions where these must be done in order to save an imperiled kidney. As to the value of x-ray examinations, Major Hamm and I believe that a routine KUB is indicated in all cases with a history of recumbency of two months or longer on first coming out of plaster, especially in those in which any abnormal findings have been noted. In those cases in which stone has actually formed to any demonstrable degree, frequent x-ray check-ups at six months periods for at least two years are advisable, in order that the serious late effects on the kidney may be avoided.

COLONEL C. S. BECK: At Fletcher General Hospital a few days ago, I found that Major Leader had been assigned to the fracture ward of the Orthopedic Service. In a period of 6 weeks, he picked up about 13 patients who had urinary calculi. This experience suggests the advisability of having an urologist on the Orthopedic section so that these complications will be picked up. The Orthopedist is too busy to concern himself with urological complications and the assignment to Orthopedics of someone with an urological background is worth consideration. Perhaps it would be good thing to have an urologist on every Orthopedic Service. I am also very much interested in the possibility of a nidus for a stone being developed in a patient without showing any evidence of the stone while he is in the hospital. The possibility exists that these patients might develop stones in the urinary tract after they are separated from the Army. This is a problem which may present itself in the future.

MAJOR S. L. RAINES: I have greatly enjoyed these papers. At England General Hospital we have a great many cases who are recumbent, since we are an amputation and neurosurgical center. I would like to bring up one matter that has not been mentioned until now. We are all pretty well agreed that just recumbency with or without amputation or infection, causes calcium to leave the bones and become excreted by and deposited in the kidneys.

The underlying cause of this change is not fully understood and will no doubt require careful and thorough investigation, by workers trained in such procedures. I would like to suggest that in addition to all the work done on caring for these patients, after stones are formed, we consider the problem of preventing such movement of the body calcium. It is a biochemical process and I believe a biochemist and such other technical help as is needed could be assigned to study this problem in one of our hospitals where so many men are confined to bed for long periods. Few, if any, civilian groups would have the cases available for such periods of time as our Army hospitals have just now.

I have enjoyed this presentation very much indeed.

DR. JOHN E. HOWARD: I am grateful to Colonel Poer for the invitation to be present at this conference and have enjoyed very much the papers that have just been presented. It occurs to me that certain recent observations on the metabolism of calcium in patients at bed rest and in casts and those suffering fractures may be pertinent to this discussion and perhaps change our orientation somewhat in our therapeutic efforts.

Previously healthy patients with fractured femurs, at bed rest in casts, excrete steadily increasing amounts of calcium in the urine up to a period of

approximately 30 days, at which time such calcium excretion reaches a plateau level where it is maintained for a long time, presumably until mobilization of the patient takes place. Smaller increases of urinary calcium occur when healthy patients are simply put to bed in casts without fracture. Studies have been made of the effect of various dietary changes during the plateau period of greatest calcium excretion on such fractured patients and were - to us, at least - very surprising. A diet which contained minimal quantities of calcium, for example, 0.2 gm.q.d., was carried on for a period of a week or two and then changed to one containing 2.0 gms. calcium or higher in the form of milk. Then the original diet was resorted to again for a period of observation. There was little or no change in the amount of urinary calcium excretion following these dietary changes. Even if we gave calcium in the form of lactate in large amounts, we found but little increase in the amount excreted in the urine. Doses of vitamin D far in excess of the usual therapeutic levels also seemed to make but little difference in the amount of calcium which appeared in the urine. We were unable to detect any change in the urinary calcium excretion from the administration of sulfonamide compounds. This leads to the question whether the strict elimination of milk and vitamin D from the diet and the restriction of sunlight to these patients is really serving the desired purpose.

It seems clear that under the circumstances of bed rest and immobilization for fracture, the bones rarefy and the movement of lime salts out of such bones is transferred from the blood to the kidneys and is excreted via the urine. The quantities of calcium thus appearing in the urine must surely be a major factor in the production of stones in these patients which, we have heard today, is so very common an occurrence. These stones are almost invariably calcium phosphate or carbonate in character.

We have as yet no true idea of the circumstances or stimuli which induce bone cells to make new bone or what stimuli induce bone resorption. It seems very likely that the bone cells themselves are metabolically active in both of these procedures. We do know crudely that one stimulus to bone formation is exercise of the part, and that immobilization or reduction of blood supply are conducive to, or stimulate, if you will, bone resorption - for example, acidosis and parathyroid hormone. Efforts should be made, it seems to me, and are being made, to determine the fundamental stimulus which is active in bone resorption, in these patients. If such could be found, we might eliminate it and, hence, prevent atrophy of disuse. This would be getting at the problem at its source. Should such fundamental information become available, we might be able to eliminate the problem of stone formation in these people, at least reduce the problem of stone formation to the same level of frequency as occurs in the populace at large.

MAJOR P. W. SWEETSER: I would like to point out that if all this physiology and pathology is true then the physiology of exercise is true. The use of Class IV Physical Reconditioning will combat stasis and sluggishness. It cannot be proved that kidney stones will be immediately prevented or cured, but exercise in bed is an important adjunct to other treatment. At Baker General Hospital we have been giving Class IV Physical Reconditioning routinely to patients in bed. These patients feel better than those who do not have any exercise. They are very receptive and seem to look forward to it. I recommend strongly that the individual medical officer give more attention to the use of Physical Reconditioning for his patients. The system has been laboriously organized - why not accept its benefits?

COLONEL I. HIMS GAGE: Have any discrepancies been noted in the incidence of kidney stones in colored soldiers? I have seen many stones but I have not seen as many in colored troops as I have in the white.

DR. HUGH JEWETT: There is one question I should like to ask. Dr. Howard has stated that his studies have shown that urinary calcium is not increased by the addition of milk to the diet. However, milk is exceptionally rich in phosphorus. According to Dr. Fuller Albright of Boston, per gram of protein, milk contains three times as much phosphorus as muscle. Since the stones under discussion are practically always composed of calcium phosphate, should or should not milk be excluded from the diet of these patients because of its high phosphorus content?

MAJOR J. J. JOHNSON: In answer to the question concerning renal stones in colored soldiers - we have seen none but we have had very few colored patients.



The points raised by Dr. Howard are interesting and important. Flocks has shown, however, that a high calcium diet will increase the amount of calcium excreted in the urine. Also the phosphorus content of milk must be considered and since most of these recumbency stones are calcium phosphate it would seem much wiser and safer to eliminate milk from the diet, or at least keep its intake at a reasonably low level. Although ammonium chloride may mobilize calcium from the bones, still in some cases a properly acid urine will cause a dissolution of the stones which have already formed. If the patient can be kept under proper observation the use of this drug seems justified in an effort to obtain the very desirable result of dissolving the stones.

MAJOR F. C. HAMM: We have had no cases of stone in colored patients included in the series referred to in this paper. I can recall only three instances of urinary stone in the colored soldier. These instances were observed before our present survey was carried out. I do not know how many patients we have seen, or what the ratio to the white patients has been. It is my belief that the relative absence of stones in colored troops is due to a racial factor, rather than their acid ash diet, in as much as the food in the Army is the same for all soldiers.

Pulvertaft has observed an increase in calcium output following prolonged exposure to sunlight in recumbency cases, and he advises against excessive exposure to sunlight. I believe that these observations should be repeated, and that we should not adopt a policy of excluding heliotherapy from these patients. I cannot believe that a moderate amount of sunlight is harmful.

# PROCEEDINGS OF THE CONFERENCE

May 11, 1945

Afternoon Session

## UROLOGICAL CONFERENCE, CONTINUED

LT. COL. FRANK MAYFIELD, Percy Jones General Hospital, presiding: Despite the fact that the crowd has not gathered completely, it is felt that we should proceed with the program. As I open the afternoon session of this delightful conference, I should like to acknowledge the honor that Colonel Noyes and Colonel Beck have conferred upon me to attend this meeting and giving me the honor to preside. As noted by the presiding officer this morning, the last paper scheduled for this morning will provide the opening paper for this afternoon. I wish to present Major George Prather of Ashford General Hospital who will speak on "War Injuries of the Urinary Tract."

MAJOR GEORGE PRATHER: Soldiers who have received injuries of the urinary tract comprise one group of patients seen by the urologist in named army general hospitals.

Penetrating injuries by bullets or shell fragments have apparently involved most every part of the urinary system from the upper pole of the kidney to the external meatus. In the group of urinary tract injuries, serious disruption of adjacent structures also forms an important part of the surgical problem.

Crush injuries more commonly injure the bladder and membranous urethra and are not uncommon in fractures of the pelvic girdle.

The purpose of this communication is to present factual information regarding a selected and varied group of cases seen at the Ashford General Hospital.

### KIDNEY INJURIES:

The named general hospital receives this type of injury after all the excitement of diagnosis and treatment is over. If the injury has been severe, nephrectomy has been done and the wound has healed before arrival at the zone of the interior. Careful perusal of the clinical records from overseas would warrant a congratulatory telegram to the surgeons in evacuation hospitals, surgical units and other forward installations whose surgery has permitted continuance of life. Our job in the zone of the interior would appear to be to estimate renal integrity and initiate proper disposition of the patient.

Two cases of this type illustrate the above remarks.

Case 1. In August 1943, in Sicily, a 35 year old T/5 received a penetrating wound of the left flank. This was caused by a 45 calibre bullet.

Laparotomy was done at a field hospital. Two perforations on the lesser curvature of the stomach and one perforation of the small bowel were sutured. A left transperitoneal nephrectomy was also done for a penetrating wound of the kidney hilum. The bullet was found in subcutaneous tissue of the left epigastrium.

During the immediate operative and postoperative period, the soldier received 10 units of plasma and 750 cc. of blood.

After admission to Ashford General Hospital, the urine was found to be normal, renal function tests were adequate, and the intravenous urograms demonstrated a normal right kidney.

The patient was sent to duty in a non-combat area.

Case 2. In September 1943, in Italy, a private received a shell fragment wound of the left chest wall which fractured the 7th rib. The following day laparotomy was performed at an evacuation hospital where extensive



intraperitoneal and retroperitoneal hemorrhage was found. A tear of the mesentery of the splenic flexure was sutured and a left transperitoneal nephrectomy done. The patient received 500 cc. of blood immediately after operation and had a normal convalescence.

Following admission to Ashford General Hospital, the urine was found to be normal, renal function was also normal and intravenous urograms satisfactory. X-ray of the chest disclosed no abnormality. The patient was therefore sent to duty in a non-combat area.

#### URETERAL INJURIES:

It is difficult for the ureter to receive a penetrating type of wound without injury to abdominal organs. The abdominal injuries are usually more evident, more serious and rate prompt surgical treatment. The ureteral injury may not be immediately evident and will likely need cystoscopic and retrograde study for accurate diagnosis. In some cases weeks or months may elapse before final opinion in regard to the ureteral injury has been completed. The following four cases will illustrate these points.

Case 3. In July 1943, in Sicily, a soldier received a penetrating shell fragment wound of the upper abdomen. Laparotomy was done on board ship the same day. Three inches of transverse colon were resected and a laceration of the second portion of the duodenum was sutured.

Two days later urine began to drain from the laparotomy wound. Twenty days after injury an intravenous pyelogram indicated a normal right renal pelvis and ureter with two small shell fragments near the midportion of the right ureter. Two days later at a station hospital a right flank incision was made evacuating a large hematoma. Urine began to drain through the flank wound and fever subsided.

Urinary drainage from the flank incision continued and intravenous pyelography was repeated two months after injury. The examination disclosed an abnormal right kidney. Two days later cystoscopic study indicated that a right ureteral catheter entered the flank sinus rather than proceeding to the kidney.

A few days later a right nephrectomy was done because of the persistent flank fistula. Convalescence was normal. Following admission to Ashford General Hospital, the urine was found to be normal, metallic fragments near L3 and L4 were asymptomatic and pyelography demonstrated a normal left kidney. The patient was returned to duty in a non-combat area.

The above case illustrates the extent of stricture formation and pyonephrosis which developed within seven weeks following demonstration of a normal kidney and within nine weeks following ureteral injury. It also illustrates the fallibility of intravenous urograms in detecting ureteral injury early.

Case 4. In July 1944 while dropping equipment to paratroopers in France by plane, this S/Sgt was hit by a 30 calibre bullet from enemy ground forces. The bullet penetrated the left hip and pelvis and entered the abdominal cavity. About four hours later at a station hospital, two perforations of the bowel and two perforations of the bladder were sutured during laparotomy. A suprapubic tube was left in the bladder. Traction was used for the fractured left hip for a period of three weeks, after which a bilateral hip spica was applied.

During convalescence it was noted that urine drained from the wound over the left hip even while the cystostomy tube was in place. Intravenous urograms overseas demonstrated the extravasation of opaque material outside the bladder and inside the left acetabulum, but it was difficult to detect the source of the extravasation.

The patient arrived at Ashford General Hospital in a plaster spica on 29 August 1944. The abdominal wound was healed and the patient was voiding without much difficulty. Urine continued to drain from the wound over the left hip and methylene blue given by mouth appeared on the dressings. A highly colored phenolsulphonphthalein solution introduced into the bladder failed to appear on the dressings over the hip.

About 5 September 1944, the patient began to run a septic type of fever

and by 9 September the urine drainage from the wound over the left hip ceased. The fever continued.

On 11 September 1944 after removal of the plaster spica, cystoscopy demonstrated a 400 cc. residual of cloudy urine and several hundred small stones in the bladder. These were removed with the Elik evacuator. The right ureteral orifice was easily visualized and catheterized. Indigocarmine appeared from the right ureteral catheter within three minutes. The left ureteral orifice could not be visualized in the bladder or posterior urethra and no indigocarmine entered the bladder during the thirty minutes following intravenous injection.

Intravenous pyelography indicated an apparently normal right kidney and multiple calculi in a nonfunctioning enlarged left kidney.

It is probably that this soldier had received a penetrating wound of the lower left ureter on 7 July 1944 at the time of his other injuries and that gradual ureteral occlusion had developed and resulted in a calculus pyonephrosis.

On 16 September 1944, under ether anesthesia, the twelfth left rib was resected and the left kidney easily exposed and quickly removed. The kidney was enlarged and tense, with multiple carbuncles apparent on the surface. Culture obtained from the kidney was reported *Aerobacter Aerogenes*.

Convalescence was extremely satisfactory with immediate and continued normal temperature and immediate cessation of all drainage from the left hip.

As in the previous case, it seems probable that traumatic injury of the ureter was followed by stricture and pyonephrosis. The interval between injury and destruction of the kidney in this instance was about thirteen weeks.

Case 5. In July 1943 while doing reconnaissance near Palermo, Sicily, a 19 year old soldier was struck in the right buttocks by enemy fire. The bullet entered just below the right iliac crest near the sacroiliac junction. Exit of the bullet occurred through the anus.

Soon afterward at a forward station the ileum was resected, pelvic floor sutured, and suprapubic cystotomy done. He received numerous transfusions and other supportive treatment. Two days later a colostomy was performed.

Urine drained profusely from the perineal and anal wounds. After a period of three weeks the patient was placed on urethral drainage, and the suprapubic wound allowed to close. Drainage via urethral catheter was continued for two months. During this period urinary leakage from the anus diminished.

At the time of admission to Ashford General Hospital on 15 November 1943, there was purulent drainage from the anal wound, the patient was voiding cloudy urine and the colostomy was functioning properly.

Cystoscopy disclosed a normal bladder except for fullous edema surrounding the right ureteral orifice. A ureteral catheter passed to the left kidney easily but obstruction was found in the right ureter  $3\frac{1}{2}$  cm. from the bladder wall. Renal function appeared slightly diminished on the right. The retrograde injection demonstrated an irregularity in the lower right ureter but there was no evidence of ureteral or renal dilatation. Cultures were reported as *Aerobacter Aerogenes*.

After an interval of two months, intravenous urograms indicated the same ureteral deformity but no evidence of hydronephrosis and no urinary drainage had occurred from the anal and perineal wounds. He was discharged to a hospital nearer his home for further convalescence.

It is believed that this soldier had had a wound of the lower right ureter which was responsible for the drainage of urine through the anal wound and which closed spontaneously. Contrary to the sequence of events in the two previous cases, this patient with demonstrable distortion and



and narrowing at the site of ureteral injury showed no trend toward pyonephrosis over a period of six months.

Case 6. On 2 June 1944 a Pfc. was injured by multiple shell fragments, receiving penetrating wounds of the lumbar spine, left costovertebral angle, cauda equina, lower left ureter, and compound fractures of the right tibia and fibula. Laparotomy and debridement of wounds were done.

On 25 July 1944 the lower left ureter was approached through an abdominal incision and a metallic foreign body removed from the region of the lower left ureter. It was thought that the ureteral fistula had been cured, but an overseas note of 5 September 1944 describes urine draining from the wound over the lumbosacral spine. The operative wound had healed well.

The patient was admitted to Ashford General Hospital in October 1944 in an emaciated condition. Intravenous pyelograms showed no evidence of ureteral fistula. In February 1945 the patient developed recurrent fever and increased purulent drainage from the lumbar area. By injection of the lumbosacral wound with lipiodol, Captain Ward demonstrated a connection between this and the left ureter. Methylene blue given by mouth appeared on the sacral dressings. Cystoscopic study with retrograde pyelograms demonstrated the fistulous opening in the pelvic ureter. The kidney above was infected and contained calculi.

Left nephrectomy was done. Urinary drainage from the lumbosacral wound ceased promptly but some purulent drainage continued. Later exploration of the lumbosacral wound was done by Captain Ward. Urinary symptoms have been relieved.

In three of the four cases of ureteral injury described here, nephrectomy has been done to relieve the urinary fistula. The presence of renal sepsis and obstructive pathology were adequate justification for the removal of the kidney. The attempt to obtain a satisfactory ureteral lumen by suture or anastomosis in the presence of chronically infected soft tissue, gross urinary infection and a debilitated or septic patient would in my opinion not be wise. No doubt there will be instances in which nephrectomy can be avoided, as is illustrated in Case 5. We look for these instances but must not be swayed without reason from a surgical procedure which will promptly and surely stop the urinary fistula, permit rapid recovery and remove a source of later disability.

#### BLADDER INJURIES:

In crush injuries of the bony pelvis with resultant damage to the bladder and/or posterior urethra, the urological problems are similar to those seen in civilian life. A case handled well overseas is illustrated. Not always is the end result so satisfactory.

Case 7. On 12 November 1943, the truck in which the soldier was riding skidded over a 90 foot cliff in Italy. When brought to a station hospital in a state of severe shock, multiple contusions and abrasions were evident over the left gluteal region, thigh and knee. The right leg was externally rotated at the hip in an abnormal manner.

Catheterization five hours after injury disclosed 150 cc. of bloody urine. Cystogram with 120 cc. of ten per cent Skiodan about seven hours after injury revealed extravasation of the dye.

Following supportive treatment with plasma and blood, suprapubic cystostomy and perivesical drainage was done at a station hospital about ten hours after injury. The fractured pelvis was treated by suspension in a hammock and Buck's extension was applied to both legs.

By 17 January 1944, two months after injury, the urethral catheter and suprapubic tube had been removed and the patient was voiding.

On arrival at Ashford General Hospital on 9 April 1944, the soldier was ambulatory, the wounds well healed, and he was voiding cloudy urine with slight difficulty.

Urethral calibration found evidence of narrowing at the bladder neck.

This was corrected with dilatation. Sulfonamide medications in addition to the dilatation permitted a sterile urine by 19 April 1944. Cystograms showed some distortion of the bladder shadow, but even with the evident separation of the pubic bones there was no change in bladder level between a supine and standing position. The soldier was returned to a limited type of duty.

Although there have no doubt been many penetrating wounds of the bladder, I have seen only two patients with shell fragment or bullet actually in the bladder. In the case reported here, it became the nucleus for a bladder calculus which would defy the best lithotrite.

Case 8. In November 1943 a soldier was wounded by 88 mm. enemy mortar shell fragments while lying prone on the ground. The fragments penetrated the gluteal region, perineum, abdomen, left thigh and left foot.

Laparotomy and debridement of peripheral wounds were performed soon afterward at an overseas general hospital. Following operation it was necessary for him to be catheterized for two days because of retention, but he cannot recall any hematuria or difficulty with voiding except as just mentioned.

The soldier was in bed for a number of weeks without urinary complaints. However, when he first got out of bed, gross hematuria and dysuria were evident. These symptoms were still present at the time of arrival at Ashford General Hospital on April 1944.

Our physical examination found a low midline abdominal scar recently healed and tympanitic to percussion, a right lower quadrant scar nearly healed but draining intestinal contents, and healed wounds of the gluteal region.

Cystoscopy revealed a small sharp splinter of shell fragment protruding through the mucosa of the trigone. This was removed with cystoscopic rongeurs. In addition, there was a bladder calculus about 2 cm. in diameter lying free in the bladder. No evidence of previous bladder injury could be seen. An X-ray of the bladder region shows a metallic fragment surrounded by a halo of calcific deposit, forming a bladder stone.

Following temporary spontaneous closure of the ileostomy wound, the bladder was opened through a midline suprapubic incision and the single calculus removed. Closure was done in the usual manner using a 32 F. Malecot tube for drainage. This tube was removed ten days later and the patient started voiding normal quantities of urine shortly afterward.

Direct examination of the calculus confirmed the impression as obtained by X-ray, namely, a definite layer of calculus formation around a piece of shell fragment.

Captain Petroff has encountered a 45 calibre bullet as the nucleus for a bladder calculus. The findings in each instance were of extraordinary interest because of complete lack of signs or symptoms of bladder perforation.

#### URETHRAL INJURIES:

Although reasonably well protected on both flanks, the urethra can also be listed among the organs penetrated by enemy shell fire. Three examples follow, all of which required surgical treatment after return to the zone of the interior.

Case 9. In October 1944 while lying prone on the ground, a soldier received either a shell fragment or bullet wound. The missile entered the anus, with exit through the lower anterior abdominal wall. Colostomy, cystotomy and the insertion of a urethral catheter were done soon afterward. At an overseas general hospital the cystotomy wound was allowed to close and the urethral catheter removed. The patient had difficulty in voiding and soon the cystotomy wound broke open. Attempts were made to insert a urethral catheter on the return trip to this country and at the first general hospital after return to this country. No form of instrument could be passed to the bladder.



Following arrival at Ashford General Hospital in December 1944, urethrographic study disclosed a tortuous and severely distorted membranous and prostatic urethra. Under anesthesia, no instrument could be passed from the external meatus to the bladder or in a retrograde manner from the bladder outward. Following improvement in general condition, a perineal exposure of the posterior urethra permitted excision of scar tissue and the insertion of a 24 F catheter through the urethra to the bladder. With careful post-operative treatment and the changing of this tube under anesthesia during subsequent weeks the cystotomy healed and the urethral catheter was permanently removed about 15 March 1945. A postoperative urethrogram shows a straight channel now entirely compatible with the normal bladder action which the soldier now enjoys. Routinely, 22, 24 and 26 F sounds are passed to the bladder every 14-21 days without difficulty. The soldier is to be transferred to a center for plastic surgery of the damaged anus and closure of colostomy.

Case 10. In July 1943 a 21 year old soldier was hit by enemy strafing during an air raid in Sicily. He sustained multiple shell fragment wounds including the urethra, scrotum, right thigh, and right lower leg. The right fibula was fractured and the right sciatic nerve damaged.

A few hours after injury his wounds were debrided and a suprapubic cystotomy was performed by an auxiliary surgical group. Eleven days later at an overseas general hospital, complete obstruction of the penile urethra was noted. No operative repair was attempted.

On admission to Ashford General Hospital 25 October 1943, the soldier was tremulous and emaciated with an estimated weight of about 85 pounds. It was necessary to replace the cystotomy tube every 10 days under intravenous anesthesia because of rapid encrustation. Although he was placed on a high vitamin, high caloric diet, he ate very little and it was not until 2 weeks later that we obtained urethrogram and cystogram. These studies demonstrated complete urethral obstruction about 11 cm. from the external meatus. During the next 5 weeks efforts were devoted toward improving his general condition.

On 13 December 1943, the suprapubic scar was resected and the bladder opening enlarged. This revealed a glazed inflamed mucous membrane and calcium plaques on the bladder base. A bougie passed in a retrograde manner met obstruction at the penoscrotal angle. Incision in the obstructed area disclosed a complete fibrous stricture with a urethra of normal calibre both proximal and distal to the obstruction. After excising scar tissue, an end to end anastomosis of the urethral segments was done. A No. 22 Robinson catheter was then passed from the external meatus to the bladder and anchored in place. Approximating sutures were loosely applied to the superficial aspects of the urethra. A suprapubic tube was inserted and the cystotomy closed in the usual manner.

The postoperative course was extremely satisfactory. The suprapubic tube was removed 1 month after operation. The urethral catheter was removed 5 weeks after operation. Six weeks after operation all wounds were completely healed and the patient was voiding in large amounts. Urethrograms done less than 2 months after operation show an adequate anastomosis. Urethral dilations were done periodically and the urethra accommodated a No. 26 LaFort sound easily. Another urethrogram about 10 months after operation shows continuance of the excellent result.

During convalescence x-rays of the kidney regions revealed multiple small calculi in both kidneys. Urine culture showed Staphylococcus and B Proteus. Ambulation, forced fluids and daily doses of 100000 units of pure vitamin A were used during the following weeks. One month later the last visible calculus is seen in the right pelvic ureter. This passed soon afterward. Further x-rays 2 months after detection of the stones found no remaining calculi.

The soldier continued to make excellent progress and was transferred to the neurosurgical section weighing 118 pounds.

Case 11. A 20 year old Pvt. was wounded 5 November 1943 by shell fragments. He sustained penetrating wounds of the abdomen, left thigh and penis. Debridement and laparotomy were done 1 hour after injury. At that time a urethral catheter was inserted through the damaged organ to the blad-

der. Apparently the penile injury appeared disconcerting for soon thereafter a suprapubic cystostomy was done at a numbered general hospital, and the tube kept in place about 3 months. During this interval the penile wound healed.

Admission to Ashford General Hospital occurred in March 1944 at which time the soldier was voiding with slight difficulty. Most of the glans appeared to be absent. The external urethral orifice was contracted to a small fibrous opening which was tight to a no. 10 F. bougie. Attempts at dilatation without anesthesia were unsuccessful because of scar tissue and pain. The meatus was therefore dilated under anesthesia to no. 26 F but in less than 2 weeks the opening had contracted to 14 F size.

In an effort to permanently improve the calibre of the meatus, a resection and revision of the region was done, the principle being similar to that used in penile amputations for carcinoma.

When calibrated 1 month later the new meatus admitted a no. 19 F sound without difficulty. There were no urinary symptoms and the urine was clear. Although the gross characteristics of the penis were still a little unusual, the channel for urination had been definitely improved.

The cases presented here illustrate well the fine surgery which the patients received overseas and which permitted their return to the zone of the interior. They also illustrate the extent to which urinary tract disabilities can be improved with the excellent facilities available in the named army general hospitals.

Although often serious, either immediately or from complications, it is gratifying that many with urinary tract injuries have survived and been restored to good health with excellent urinary and genital functions.

LT. COLONEL MAYFIELD: Major Prather gave an excellent example of finishing a paper on time. I hope that this example will be followed by all speakers.

He has presented much interesting material and I am sure it will bring much discussion. I will ask that the discussion be vigorous but to the point.

LT. COLONEL CONDUCT W. CUTLER: The following report of observation on cases of this type at the Lovell General Hospital is made by Vernon S. Dick, Major, MC, Chief, Urology Section.

1. Injuries of the Kidney - Total: 6 cases.  
Nephrectomy - 3 cases.

These nephrectomies have been performed overseas for severe penetrating injuries of the kidney with extensive damage. No sequelae. Partial excision of kidney - one case, performed overseas for trauma to upper pole of the kidney, satisfactory healing.

Non-penetrating injuries of the kidney - 2 cases.  
Hematuria following severe blows of the kidney, but conservative treatment and satisfactory recovery.

Remarks: No surgery was required for kidney injuries at the Lovell General Hospital during the past year.

2. Ureter - Total: 3 cases.

One case of injury to the left lower ureter two centimeters from the orifice resulting from bullet entering the coccygeal region and passing through rectum and bladder. Urine draining through coccygeal sinus. Subsequent infection, constriction and angulation of the ureter with perforation into a chronic abscess, and hydronephrosis. Nephrostomy followed by resection of damaged ureter and uretero-vesical anastomosis. Satisfactory results. One case of injury to mid-ureter by shell-fragments, resulting in peri-urethral abscess. Drainage and anastomosis of ureter. No hydronephrosis or stricture. Ureteral fistula - one case, still under investigation.

Remarks: These lesions are relatively infrequent.



### 3. Bladder - Total: 16 cases.

Six cases admitted with suprapubic drainage still present. Three of these bladder injuries were due to penetrating wounds and three to pelvic fracture. Ten cases have suprapubic wounds healed, but with persistent infection of the bladder. In all of these there was chronic prostatitis and vesiculitis. Three developed acute epididymitis as a complication, others have had this complication overseas. These patients were practically asymptomatic when admitted, but complicating conditions discovered on the bases of pyuria. Need for careful investigation of such cases as indicated by the findings in these of the following probable causes of persistent infection:

- a. Urethral stricture - 3 cases.
- b. Vesical calculi - 2 cases.
- c. Piece of uniform in wall of bladder - 1 case.
- d. Vesical fistula communicating with chronic abscess and foreign body - 3 cases.

The removal of these factors and local treatment succeeded in clearing the infection. Infection is more slowly controlled where osteomyelitis is a contributing factor.

### 4. Urethra.

Various types of urethral stricture were observed, stenosis fistulae and loss of substance. In these the location was membranous or bulbo-membranous in eleven, penile-scarotal angle - two, penile or meatal - three. Five were associated with fractures of the pelvis, ten the result of penetrating wounds, one from a straddle injury. Two patients had urinary fistulae. Both are closing, one after meatotomy, the other after removal of cotton suture. One patient with complete rupture of membranous urethra had had suprapubic cystostomy overseas with complete obliterative scarring of the membranous area resulting. Perineal dissection and reconstruction of urethra was successfully performed at Lovell. The majority of these patients had only residual strictures on admission. Injuries to the meatus required meatotomy and minor plastic procedures in several.

CAPTAIN CLAY MILLER: I wish to congratulate Major Prather on his instructive and interesting presentation. He has been more fortunate than we have, in seeing some ureteral injuries, the resulting sequelae, and the late results. We have seen about three cases of kidney injuries, all of which had been operated upon overseas. We have seen many urinary bladder and urethral injuries, a great majority of which required further surgery. Three cases of urethral injury I recall clearly - two of these had received lacerating wounds in perineum, resulting in complete destruction of two inches of bulbus urethra. The remaining one had lost approximately one inch of the bulbus urethra in a similar manner. Nothing had been done at the time to reestablish continuity of the urethra, and only a cystostomy had been done and a large fezar catheter placed into bladder. All of these required a retrograde procedure through the urinary bladder in order to establish continuity of urethral tract. Many cases of perineal urethral injury require an extensive external urothrotomy. In view of these findings, may I suggest - in the cases requiring cystostomy, that the opening in bladder be higher and the tube placed midway between symphysis and umbilicus - also, that in cases of urethral injuries that an indwelling catheter be placed in urethra for a period of ten days followed by urethral sounding one weekly for three months with a gradual increasing interval.

DOCTOR W. H. TOWSON: Following the last war, there came to various clinics throughout the country an occasional patient with an aftermath of contusion of the kidney. Recently I had a case with such a kidney.

Slide I - This was a patient with a history of contusion years ago in the service. There has never been a repetition of hematuria and he has never had any symptoms referable to the kidney but has had symptoms referable to the gastro-intestinal tract. In the course of the X-ray investigation a huge solid mass was seen in the upper left quadrant. Here is a slide (Slide II) showing a pyelogram demonstrating the proximity of the mass to the pelvis of the kidney.

Slide III - Here is a lateral view which shows that the mass is distinctly

post-peritoneal showing no relationship to the intraperitoneal structures.

Slide IV - The specimen itself turned out to be a huge chalky mass which on chemical examination showed pure calcium carbonate. The little structure at the lower pole of the kidney was all that remained of what at one time had been a fairly good kidney. It had a markedly reduced function with no infection.

Slide V - Here is a slide of another case. This patient was 60 years old with a recent history of a fall on the icy streets followed by a hematuria and symptoms of contusion in the left kidney. I show this slide merely as a diagnostic problem. Having passed blood and giving a recent history of an accident with a distortion of the renal pelvis, it was possible that the distortion might be due to posttraumatic blood clots. We waited for two or three weeks after all the symptoms of hematuria disappeared and getting relatively no blood cells from the catheter drainage on this side, and since all the pyelograms were similar, we then made a diagnosis of papillary carcinoma which at operation it turned out to be.

LT. COLONEL FRANK MYFIELD: We will now proceed with the symposium on "The Care of the Paralyzed Patient". General Kirk and General Rankin have already emphasized the importance of this problem. We are guided by very specific directives as to our duty in regard to these patients and also provided with sufficient authority to carry out the intent of these directives. There has been scheduled for us this afternoon many papers, all of importance. It has been decided to revise the schedule slightly, the first two papers will be read before discussion.

The first speaker is Major Charles Elkins whose subject will be "Neurological Aspects."

MAJOR CHARLES W. ELKINS: Prior to World War II there was no great unanimity of opinion as to the proper therapy for a patient who had received a spinal cord injury. Due to the increase in numbers of this type of injury since the advent of the war, the attention of many individuals in the Army Medical Corps has been focused on this problem. The Army Medical Corps has initiated certain concepts and principals in therapy which will serve as a guidepost in the future for the treatment of a type of injury which is bound to be more numerous as our age becomes increasingly mechanized.

The paraplegic patient presents many problems, one of which is treatment from a neurological or neurosurgical aspect. This treatment begins from the moment of injury and does not cease until everything possible has been done to insure a satisfactory outcome to the illness within reason. A definition of satisfactory outcome from a neurosurgical point of view may be stated as follows. It must be determined that further surgery is not indicated in order to permit or to aid in recovery of function to the spinal cord in both sensory and motor spheres. (This point will be further elaborated by Lt. Colonel McCravey.) The patient must be free from pain. The patient must be relieved of incapacitating spinal reflexes and paraplegia in flexion.

A detailed discussion of the early neurosurgical treatment of spinal cord injuries such as methods of transportation from the sight of injury so as not to increase damage to the spinal cord, and the various indications for early laminectomy have been purposely omitted as being outside the scope of this symposium. The care of the bladder and bowels and the methods of prevention of decubitus ulcers are outside the scope of this paper. Consequently, I wish to limit this discussion to the causes and treatment of pain in spinal cord injuries and to observations made at this hospital on certain types of incapacitating spinal reflexes and paraplegia in flexion, with a description of a method for relieving these distressing symptoms.

In considering pain, it must be realized that in general, this type of patient is prone to have a low threshold particularly if in a debilitated state. Furthermore, the danger of drug addiction cannot be lightly considered. Consequently, the decision as to the institution of a procedure for the relief of pain must be tempered by individual knowledge of the patient. This decision may well tax the judgement of the most experienced surgeons.

The cause of pain following injury to the spinal cord may be relatively simpler or somewhat obscure. These facts are well known. (1) Retained foreign



bodies in close proximation to pain tracts or posterior nerve roots may be the etiological factor. (2) It has been proven that arachnoiditis following trauma to the spinal cord may result in pain either generalized or girdle in character. (3) Bony overgrowth, from healed fractures, impinging on nerve roots may be responsible for pain in certain cases. (4) Involvement of the sympathetic nervous system may result in a most distressing type of pain. It is the sometimes difficult job of the neurosurgeon to identify the proper etiological factor and to institute appropriate measures for relief.

The methods for the relief of intractable pain are well known to all neurosurgeons and should be employed when indications arise. However, a note of warning must be sounded as to the types of procedures employed when dealing with patients whose spinal cords have been damaged. It is true that the primary consideration is usually the relief of pain and yet if the procedure contemplated would result in an increase in the patient's incapacity, consideration of a less extensive and less incapacitating procedure should be given even at the expense of a certain knowledge of the outcome.

Removal of retained foreign bodies and bony overgrowths is fundamental surgery when their presence has a reasonable chance of being the causative factor of pain. Alcohol injection of posterior nerve roots may be employed if the pain is segmental and the etiological factors are obscure or the chances of relief by more direct methods slight. This procedure is not usually incapacitating unless employed in the low sacral region where there is danger of interfering with bladder and bowel function. Alcohol injection into the subarachnoid space should be generally avoided because of the danger of upsetting the relationships of a bladder whose physiology is already precarious. Of the surgical procedures commonly employed, section of posterior nerve roots is the simplest and offers the best chance of success particularly in girdle type pain. A controversial point may be injected here and later discussion invited. Will the interruption of skin reflexes following section of certain posterior roots have deleterious effects on an autonomous bladder?

If these more simple methods for relieving pain result in failure and involvement of the sympathetic nervous system has been discarded as the etiological factor, a section of the spino-thalamic tract may be employed. This is not a particularly hazardous procedure but has certain disadvantages. The tract is not on the surface of the cord and therefore the section cannot be done under direct vision. Certain pain fibers, therefore, may be left intact. Carefully performed, however, this procedure may result in relief of pain where other methods have failed.

In general then, it must be born in mind that while this type of patient does not readily tolerate pain, neither do they tolerate arduous or extensive surgical procedures and therefore following careful consideration of the cause of pain, the simplest procedures available which would seem to offer the best chance of success should be employed in order to relieve this most distressing symptom.

Before beginning the discussion of spinal reflexes, I would like to point out their statistical importance so far as our group of patients is concerned. Out of a total of 69 spinal cord injuries, both complete and incomplete, as of the first of May, 24 had spinal reflexes, the severity varying from complete to mild incapacitation. Incapacitation must need be defined when used in describing a symptom in a paraplegic patient. When one considers that the ultimate aim in the treatment of a paralyzed patient is some method of ambulation, it may readily be seen that automatic spinal reflexes and particularly the frequently coexisting complication of paraplegia in flexion may be considered incapacitating.

One might as well admit at the onset of any discussion of spinal reflexes that the entire story is not known. A few simple facts have been proven and further elaboration of spinal reflex phenomena in human beings should be a direct challenge to present day neurophysiologists.

A term which I have discarded because of reasons to be elaborated presently but which is generally used to describe these phenomena is "Mass Reflexes". A mass reflex has been described as a maximal motor response in flexion to a minimal sensory stimulus in an animal with a transected spinal cord. My reasons for discarding this term are that not all of our patients with proven transections of the cord have maximal motor response to even

strong sensory stimuli and indeed some do not have even minimal response. To continue this discrepancy further, we have observed patients with partially transected cords who demonstrate probably maximal motor response to minimal stimuli but the response is in extension and not in flexion. Thus, I believe the term spinal reflex to be the more accurate term of the two.

The mechanics of a simple and uncomplicated spinal reflex consists of sensory stimuli entering the spinal cord through the posterior nerve roots and after transmission to large number of anterior horn motor cells, emergence as efferent stimuli to motor groups. Slide 1 demonstrates this cycle.

It would seem logical, therefore, that an interruption of the cycle would control spinal reflexes in the area involved depending on where and over what extent the cycle was interrupted. This has been done on three patients at this hospital with success.

Slide II demonstrates a patient with paraplegia in flexion and automatic spinal reflexes. Providing that the patient is incapacitated within the limits of the definition previously given and that all hope of spontaneous recovery has been abandoned, the procedure of anterior root rhizotomy which we have employed seems indicated. Slide III is our artist's conception of the anatomy of the area (follows description of operation and roots sectioned) Slide IV demonstrates same patient as slide II, three weeks postoperative with flexion contractures relaxed.

It has been a distinct pleasure to take part in this symposium on the paralyzed patient and to realize that after many dark years the problems of the paraplegic are being brought to light. "A defeatist attitude can no longer be tolerated." I thank you.

LT. COLONEL FRANK MAYFIELD: The next paper by Lt. Colonel Augustus McGrawey of Wakeman General Hospital who offers "A Plea for Exploration of the Spinal Canal and Cauda Equina Injuries".

LT. COLONEL AUGUSTUS MCGRAVEY: The Neurosurgeons are divided in their opinion as to the indications for exploratory laminectomy in injuries of the spinal cord. Perhaps the large number of cases treated during this war will decide this controversy.

Such authorities as Frazier<sup>1</sup>, Lyster<sup>2</sup>, Mock<sup>3</sup>, Oldberg<sup>4</sup>, Wechsler<sup>5</sup>, Love<sup>6</sup>, Munro<sup>7</sup>, Coleman and Meredith<sup>8</sup>, Kennedy<sup>9</sup>, and more recently Spurling<sup>10</sup>, have advocated exploratory laminectomy. With the present advances in surgery, the operative procedure can be done with a minimum of risk to life. Thirty-two (32) laminectomies have recently been done at Wakeman General Hospital, under local anesthesia, without a death or postoperative complication.

If a conservative policy is adopted, it is very difficult to select those cases which may be helped by surgery. The neurologic examination can only reveal the degree of physiologic interruption but not the extent of the anatomic lesion. The Queckenstadt Test has been eliminated as a criteria in selection of cases for laminectomy by Mayfield.<sup>11</sup> Poppen and Hurxthal<sup>12</sup> have demonstrated that the Queckenstadt Test gives a normal response as long as the lumen of the subarachnoid space is not less than the bore of the needle used. Likewise, X-rays of the spine are not always reliable. Depressed bone fragments into the neural canal are often found at operation with a previous negative X-ray report.

At Wakeman General Hospital, seventy-one (71) cases have been admitted with penetrating wounds of the spine with spinal cord and cauda equina injury. Thirty-six (36) of these cases still require routine paraplegia care of which eighteen (18) are complete paraplegias. This report will be confined to that group of thirty-six (36) still requiring paraplegia care. Thirteen (13) of these cases had adequate previous operative treatment with the time between injury and surgery varying from three (3) hours to twenty-five (25) days. Five (5) of these cases have shown partial return of motor and sensory function, of which two (2) were cervical, one (1) dorsal, and two (2) cauda equina injuries. Two (2) cases not previously operated are awaiting surgery, which has been deferred until adequate nutrition can be established.

The remainder of the twenty-one (21) cases have had adequate exploratory laminectomies. Six (6) cases were explored for foreign bodies, in or adjacent to neural canal. Two (2) were bone fragments, and four (4) were shell



fragments. Three (3) showed neurologic improvement. Three (3) had severe pain which was relieved by surgery.

Seven (7) were operated for pain only. All were cauda equina and conus lesions of which four (4) were improved, three (3) were only temporarily relieved, and cordotomy is contemplated for this group. Eight (8) cases have not had previous exploratory laminectomies. Seven (7) involved the dorsal cord and one (1) the cervical cord. Two (2) incomplete lesions showed definite improvement and one (1) complete lesion is now showing movement of toes.

The cause of operative treatment in the group with pain and foreign bodies is obvious and results are often gratifying. Of the group not previously operated, six (6) showed complete physiologic interruption by neurologic examination and one (1) of these was definitely improved. This is considered significant since this group is usually considered hopeless.

Much care has been taken in selecting and preparing these cases for surgery. Emphasis has been placed on the care and treatment of urinary tract infection and decubitus ulcers. No surgery is done until all nutritional deficiencies have been corrected, and there is a balanced protein metabolism.

This group of patients is very anxious to have any type of surgery which may offer the slightest hope and will often ask for exploratory surgery.<sup>10</sup> Our reaction may best be expressed by quoting from Col. R. G. Spurling's recent overseas report.

"It has been the policy of this theater to explore all gunshot wounds of the spinal cord in which there is the slightest doubt of complete anatomical disruption of the spinal cord. The reasons for so doing are many but the unanswerable one seems to be that it is the humane thing to do even though the results of operation are so often disappointing. After all, it gives the patient and their families a prognosis".

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LT. COLONEL FRANK MAYFIELD: These two papers are now open for discussion. The arguments for and against laminectomy and for rhizotomy are on issue and is by no means settled. We have rarely done laminectomies on these patients after they arrived here. At the moment, the treatment of the acute injury is not our problem but it may become so at any time. We have with us this afternoon, Lt. Colonel Edgar Kahn, who has recently returned from a long tour of duty in the European Theater of Operations. I will ask him to open the discussion with particular emphasis on the early treatment of these patients.

LT. COLONEL EDGAR KAHN: I had some experience with operation on the spinal cord in patients who had high explosive and gunshot wounds of the cord. Our results were extremely disappointing. This operation can be very difficult. I still agree with the speaker that the cord should be explored just the same. It should be done by a person with great experience. Many cases have been quite successful. Not all of my cases showed marked improvement in five days. On the other hand there were those who did exceedingly well. One case was absolutely amazing. He had a missile two centimeters across and two small ones beside it. They were removed without difficulty. This patient had a good recovery with no weakness. I have had three such cases. This work has got to be continued. I think Colonel McCravey is to be congratulated in keeping on with it, even though he has only had one good result in six complete lesions. But we must not forget these patients.

MAJOR GEORGE MALTBY: Major Elkins' paper was extremely interesting and covered the major neurosurgical problems in the handling of these cases. The complication of mass reflexes and spinal reflexes, or whatever term you would like to use, can be very serious. I feel that the operation of anterior rhizotomy may be at times a life saving procedure. We have done one such operation on a man with very marked flexion contractures. They had become so severe that he had had suicidal ideas. The operation in this instance was extremely successful. His legs have straightened out and we feel that he is making marked improvement. Once the spasms are controlled it is then possible to go ahead with the ambulation and further rehabilitation of the patient. I think that it is important to use extreme conservatism in picking the cases for this operation.

Question of the treatment of pain in the spinal cases has been a problem for us. We have seen a fairly large group of patients with cauda equina lesions and severe pain in the lower extremities. The majority of these cases are markedly relieved by exploration of the cauda equina; which we believe has the same results as neurolysis in certain painful peripheral nerve lesions. We have tried sympathectomy for relief of this type of pain in two instances without benefit. It is my feeling that the method of choice in relieving the pain in this group of patients is a high dorsal cordotomy.

LT. COLONEL BARNES WOODHALL: After visiting many of the neurosurgeons of this country and reviewing their cases of paraplegias it seems to me that we have now arrived at the point where neurosurgical opinions concerning these problems are fairly well established. There is no question that we have a definite responsibility to relieve pain, although it must be admitted that this symptom may vary considerably from patient to patient. The pain associated with the presence of large foreign bodies is a clear cut syndrome and is easily relieved. In cauda equina lesions neurolysis will often diminish the pain sometimes encountered in such patients. I have been impressed by the operative relief of this type of pain noted in overseas reports. I agree with Lt. Colonel McCravey that cordotomy is an operation that we have used too infrequently in these individuals. We have very little to lose with this procedure and the results have been good in the hands of competent surgeons.

I am in complete accord with Major Elkins concerning the problem of reducing mass spinal reflexes. The problem, however, is not always as simple as that demonstrated by his patient. In these severe instances where the spinal injury is complete anterior rhizotomy must be done. In the incomplete cases conservative measures of restraint should be followed together with the entire regimen of paraplegic care. Such spinal reflexes then have a tendency toward spontaneous resolution.

Exploratory laminectomy in uncomplicated spinal cord lesions is of dubi-



ous value. One should not expect neurological improvement at a late date and this is somewhat confirmed by certain statistics which I shall mention in chronological order. Among thirty-five cases of paraplegias operated within a time period of three hours to five days after injury, fifty-seven per cent showed improvement. Among 386 cases operated upon at a later date in base general hospitals, ten per cent showed improvement. Colonel McCravey has reported but one case showing evidence of improvement out of six late after injury. Other groups of paraplegics operated upon three to four months after injury have failed to show neurologic improvement which could be correlated with the operative procedure. Any objection to exploratory laminectomy naturally does not apply to cauda equina lesions where the presence of foreign bodies, depressed bone fragments, inadequate early operation or pain appear to be indications for exploration.

LT. COLONEL SPENCER BRADEN: There are one or two points I should like to bring out. I agree with Colonel Woodhall that considerable discretion should be exercised in the selection of those cases which are to be operated upon for the relief of mass reflexes. We have, at Nichols General Hospital, been trying very hard to dodge the issue of operation on this type of cases. We have recently, at the suggestion of one of our internists, Captain David F. James, been using Curare in an effort to control the painful spasms in these cases. We were fortunate in obtaining the cooperation of The Surgeon General's Office in this matter. We have used the drug in varying doses of from 10 to 100 mgms. in five cases. It is, of course, too early for us to formulate a definite opinion but we do feel that it may possess very definite possibilities. As you know, this drug has been used by the anesthetists in conjunction with general anesthetic agents for the purpose of promoting greater muscular relaxation. We have one patient who has been relieved of his painful spasms for as long as 10 to 15 hours, and considers it beneficial enough to request the drug at the end of that time. Prior to its administration he had experienced great difficulty in obtaining a night's rest and physiotherapeutic procedures were exceedingly difficult because of the reflexes.

To date we have observed no contraindicating deleterious effects even after administration of 100 mgms of the drug. Slight transitory diplopia has been complained of, with an associated feeling of slight unreality.

In the evaluation of results of operative intervention on paraplegia cases, a sharp line of distinction should be drawn between the cauda equina and the spinal cord. The cauda equina has the characteristics and is in essence a peripheral nerve and one would therefore expect it to behave in a similar manner. It certainly must be said that it can withstand trauma and be expected to recover, where the same situation in the spinal cord proper would be agreed to be hopeless.

LT. COLONEL CONDUCT W. CUTLER: Reported from Observations on the Neurosurgical Service - Cushing General Hospital - W. P. VanWagenen, MC, Lt. Colonel - Chief of Neurosurgical Section.

1. Neurological Aspects - During the past year sixty-seven patients of this type have been admitted to Cushing General Hospital. Ninety-two percent of cord injuries were caused by gunshot wounds and shell-fire. Eight percent were crushing injuries. Of sixty-four cases, three had cervical spine injuries, forty-four dorsal spine injuries, seventeen lumbar spine injuries. Twenty-five percent had incomplete paralysis with sufficient motor function of the legs to permit walking with braces. Two who had complete paraplegia on admission developed nearly normal recovery in three months' time. All cases on admission had paraplegia or paraparesis of a flaccid type. From three to nine months was required for a return of deep reflexes and Babinski. Sensory level was sharply demarcated. Twelve cases revealed complete sympathectomy effect. Twenty showed increased sympathetic tone with cold moist feet. All but one case had flaccid paralysis of the bladder. Three cases with priapism had contusion rather than transection of the cervical or dorsal cord. To date no case which on admission showed no flicker of motion in the foot or leg has shown any improvement up to one year's hospitalization. Only two cases of cauda equina lesion which showed no flicker of motion on admission showed later improvement.

2. Exploration of the Spinal Cord - In sixty-seven cases of paraplegia, thirty-four laminectomies have been done overseas. Fourteen laminectomies were done in this hospital because of total manometric block or in order to determine prognosis and the justification for anterior root resection of the lumbosacral roots to diminish spasm. All laminectomies at Cushing were discontinued December 1944, as directed by The Surgeon General.

In forty-eight cases of laminectomy, both those done overseas and here, the following findings were recorded:

10 cases - transection  
14 cases - normal cord  
11 cases - contused cord

In forty-eight cases of laminectomy sixteen eventually improved and developed sufficient function to permit walking. Twenty-two have shown no improvement in one to twelve months. It is to be inferred that these twenty-two cases of non-improvement include the ten cases of transection and some of the cases of contused cord. Fourteen laminectomies done at Cushing Hospital were late operations, generally several months after injury. The findings were about equally divided between normal appearing cord, transection of the cord, and contused cord. Four have shown improvement.

LT. COLONEL FRANK MAYFIELD: Before asking the essayists to close, I would like to say a word of caution in regard to rhizotomy and other destructive operations designed for the control of mass reflexes. I feel that the cases that require this operation are rare and that it should be deferred for at least a year after injury unless there is absolute proof that the cord has been completely transected. Many of these tend to become less forceful and less easily excitable with the passage of time. Furthermore, it seems to me that the attending doctor is more anxious to do something about these massed reflexes than the patient or the nurses and attendants who care for them. Unless these reflexes are definitely interfering with nutrition or the care of the skin and bladder, I don't believe such an operation should be done. Having once decided that such a procedure is necessary, however, I would certainly consider that the procedure recommended by Major Elkins would be the one of choice.

I will ask the essayists to close.

MAJOR CHARLES W. ELKINS: I wish to thank the neurosurgeons present for their discussion of my paper and I am glad that the feeling towards conservatism has been made evident. The three cases of rhizotomy performed at this hospital were on proven complete lesions.

One might consider the possibility that posterior instead of anterior rhizotomy be performed to control spinal reflexes. Dr. Frazier did this in 1911 on a patient with spastic paraplegia, syphilitic in origin. The patient did not live long enough to evaluate results and no autopsy was performed. To the best of my knowledge, nothing further has been reported on this procedure and I think it should probably be considered.

LT. COLONEL AUGUSTUS McCRAVEY: I am very grateful for the excellent discussion of this important subject, and I am sure it has aided a great deal in the solution of this problem.

LT. COLONEL FRANK MAYFIELD: If there is no further discussion, we will have the next paper entitled, "Urological Aspects" by Captain Boris Petroff of this hospital.

CAPTAIN BORIS P. PETROFF: In treating the patient with a spinal cord injury, the objective of the urologist is to re-establish some type of voiding which would empty the bladder, thus eliminating suprapubic cystostomies and indwelling catheters. At the same time urinary infections, which are always present, and their complications, such as pyelonephritis, cortical abscesses, renal and bladder calculi, epididymitis and peri-urethral abscesses, have to be combated.

At Newton D. Baker General Hospital a total of seventy patients with spinal cord injuries were received since September 1944. Those included complete and partial traumatic myelitis at levels from cervical 7 down to cauda equina injuries. Forty of these had suprapubic cystostomies, performed overseas. Of the remaining thirty, one had a perineal urethrostomy and one had an indwelling urethral catheter. The other twenty-eight were voiding spontaneously with varying degrees of success.

This report deals primarily with the forty patients with suprapubic cystostomy and the re-establishment of urethral voiding in seventeen of them.



The remaining patients, except one death, are still on tidal drainage or in the process of being changed over from suprapubic to urethral drainage. Of the latter, six are new arrivals who are still being studied.

As part of the general workup, a urea nitrogen and  $\text{CO}_2$  combining power are obtained as well as intravenous urograms which are extremely valuable as a matter of record in these men so that a comparison may be made with later plates in case a febrile reaction develops due to urinary complications. The suprapubic tube is checked for its adequacy, changed if necessary on arrival at this Hospital and connected to the closed system, manually controlled type of drainage and irrigation, so that the patient can irrigate himself with the M, citric acid buffered solution. As soon as the patient's condition warrants it, the suprapubic tube is removed, the sinus packed and a urethral catheter is inserted. Care should be taken to use a small caliber catheter such as a No. 16 or No. 18 French furnished by Medical Supply, with added holes cut in its tip for better drainage, in an attempt to avoid the occurrence of periurethral abscesses and epididymitis.

Of the thirty-eight patients changed from suprapubic drainage to catheter drainage in the past nine months, six have developed periurethral abscesses at the peno-scrotal junction, followed by fistula formation and four developed epididymitis, one of which was bilateral; now subsided. Another who had both abscess and epididymitis came to orchidectomy. These peri-urethral abscesses occurred during the use of 22 F. Foley self-retaining catheter in an attempt to avoid using adhesive tape on the penis, especially because priapism tends to pull the straight catheter out. It is possible that these abscesses might have been avoided if smaller size catheters had been employed, or if a No. 18 self-retaining 5cc bag catheter had been available instead of the larger sizes. Catheters of large size may cause necrosis of urethral mucosa at the peno-scrotal angle and lead to abscess formation. One cannot deny that the presence of urethral fistula, which heals very slowly indeed, rivalled in slowness only by the perineal urethrostomy, represents a decided handicap to the spontaneous activity of which some of these six bladders are now capable. An attempt is being made now to speed the closing of these fistulae by suture with stainless steel wire and it is difficult to state at this time what the eventual status of the patients with this complication will be.

As for epididymitis, we recently had a case which developed even though no catheter over No. 16 was ever used. The question has come up regarding ligation of the vas deferens in conjunction with a urethral catheter to prevent epididymitis, but the youthful age group and the possible effect on patients' morale have been against it. They all hope for an active sex life.

The change from suprapubic tube to urethral catheter is always a big lift to a patient's morale as the cystostomy is repugnant to most of them. The sinus heals in anywhere from two to six weeks, depending upon the condition of the patient and the size of the incision. While the sinus is closing, the urethral catheter is irrigated by the patient himself with the manually controlled closed system and his catheter is changed every week. In those patients who can stand it, an observation cystoscopy is done, using the McCarthy Panendoscope to ascertain the condition of their internal sphincter and whether it responds to voluntary effort to void. The verumontanum is found to be pale and atrophic, the prostate small and soft. At the same time the bladder is irrigated thoroughly, evacuating the fibrin, mucous and calculi which may have accumulated during the period of bladder drainage. A cystourethrogram is also done as a matter of record. Cystometric readings are taken on each bladder as soon as the cystostomy heals and sometimes through the cystostomy tube if there is not undue leakage around it. The simple water cystometer is used. Cystometric curves have been very valuable in differentiating between the hypotonic or atonic relaxed bladder and the hypertonic small bladder by mass reflexes. These mass reflexes are a great problem as urine escapes around the catheter and keeps the patient wet whenever the bladder contracts spasmodically. The cystometric curve also indicates when the patient has established a reflex bladder and the catheter can be dispensed with. The main procedure in rehabilitating the bladder in establishing reflex bladder of good capacity is institution of tidal drainage apparatus. The Stewart-Munro modification is the one used here and has given very good results.

Of the thirty-eight patients who have been placed on urethral drainage

in this Hospital, thirty have had tidal drainage apparatus irrigating and exercising their bladder for one to three months. Seventeen are voiding now with little, if any, urinary residual and all have shown increased bladder capacity which has advanced most of them from 50 to 75cc to 300 to 400cc bladder volume as contrasted to one who did not get tidal drainage and remained with a small capacity bladder and a suprapubic cystostomy. Of the remaining eight patients on urethral drainage without tidal irrigation, four were cauda equina injuries, four are those whose cystotomies have not yet healed. In time, with tidal drainage, we expect those patients with complete cord lesions to void by reflex action. So far, those with high thoracic or cervical transverse complete myelitis seem to be the slowest to respond to automatic irrigation. Those with partial myelitis have, in general, resumed bladder activity in three to four months after arrival here, although their bladders are frequently checked for residual urine. Meanwhile, while on tidal irrigation, the constant in and out flow of M solution keeps the bladders clean and the walls elastic. M solution has been the best so far for irrigating purposes. It is composed of citric acid buffered with magnesium oxide and sodium carbonate and has a pH of 4.5. Although it will not completely prevent calculus formation in the bladder nor destroy bacteria, it has given better results than 0.5% acetic acid or boric acid which we used at first. Potassium permanganate was ruled out at the beginning as it breaks down rapidly. At present 20 gallons of M solution are used each day.

The most pressing problem of the urologist in keeping these paralyzed patients alive and reasonably well is to combat urinary infections attended by chills, fever and calculus formations. All our urinary flora now contain *Aerobacter Aerogenes*, *Bacillus Proteus*, and *B. Pyocyaneus* and occasionally *E. Coli*. The staphylococcus and streptococcus have been cleared up by penicillin therapy. After each chill and elevated temperature, a blood culture is taken. So far we have had three positive blood cultures, two for *Aerobacter Aerogenes* and one for *B. Proteus*, later followed by *B. Pyocyaneus*. All three became negative in three to four days following increased doses of penicillin, blood transfusions, relief of ureteral obstruction and forcing fluids, as well as supportive measures such as oxygen tent, and digitalis therapy administered by the Medical Service.

The above mentioned gram-negative organisms which infect the urinary tract cannot be eliminated by penicillin as can the staphylococcus and streptococcus groups. They also have urea-splitting properties, causing the formation of alkaline calculi in bladder and kidneys. Of forty catheter or cystostomy patients who have had intravenous pyelograms and observation cystoscopies of bladder, twenty-eight had bladder stones of varying size and hardness, composed of calcium and magnesium carbonate and phosphates. All these urines contained *Aerobacter Aerogenes* and *B. Proteus*. These calculi are ever present. Patients with suprapubic drainage had them and after they had been removed and urethral drainage instituted within a few months they had recurred in the bladder. These bladder stones are easily removed by the Ellick evacuator through the panendoscope sheath, but the larger ones have to be crushed first with a visual lithotrite. Demineralization of the bones in recumbent patients as demonstrable by osteoporosis in X-rays, resulting in increased calcium salts in the urine, and stasis in the bladder due to incomplete emptying by catheter, especially the Foley bag catheter which may allow puddling of urine behind the retaining balloon, may account for these bladder calculi, but the gram-negative urea splitting **bacilli** are the probably factors at the bottom of this stone formation.

The treatment of upper urinary tract infection has been difficult. So far, of forty-three paralyzed, bed-fast patients, eight have developed renal calculi, some under our very eyes in the past three months. The paralyzed patient with high spinal cord lesion cannot localize renal pain and diagnosis of renal calculi depends on intravenous urograms which are taken as soon as the patient develops abdominal distress, vomiting, distention, chills or fever. Of these, eight patients with kidney stones, two have had to have operations for urethral obstruction. One had to have a nephrectomy because of cortical abscesses and stone and the second had a pyelolithotomy and since has had another stone obstructing the ureter. Three others responded to more conservative measures of passing a catheter up to the obstructed kidney as, fortunately, the calculi was small. One such patient with transverse myelitis at the 7th cervical vertebra had developed six small stones in the right kidney, obstructing it with the accumulation



of heavy green pus above. Two catheters were passed up to the kidney, pus evacuated and all but three stones dissolved with continuous irrigation with G solution. The remaining three stones are not obstructing now, but may grow as *B. Proteus* is present still.

One death in January 1945 was due to a pyonephrosis and lung abscess as well as urethral calculi, the culture of renal abscesses showing *A. aerogenes*.

Just as penicillin, sulfonamides and blood transfusions combined with general medical and surgical care have served to keep these boys alive so far, by combating streptococcus and staphylococcus infection, so it is up to the urologist to cut down urinary infections and calculus formation due to gram-negative bacilli. It is up to a new anti-biotic like penicillin to clear up these organisms which penicillin will not destroy.

Aseptic care of the Catheter tidal drainage apparatus and collecting bottle and tubing are taught to each corpsman on the ward. Two specialists are on duty all the time for urological care only. The patient himself is instructed in how to avoid contaminating his catheter in an attempt to reduce the incidence of infection.

In the meantime, the paralyzed patient will be most benefitted by general building up of his resistance to infection and the urologist will do the most good by conservative treatment and careful watching and waiting, using every diagnostic and therapeutic method at his disposal to forestall ureteral obstruction and blood stream infections, hoping to avoid complications until a time when the patient can dispense with catheters and be on his own with a reflex bladder of voluntary voiding.

Due to the ever present threat of urinary infection, these paralyzed patients will need periodical medical observation for an indefinite period.

#### SUMMARY

In seventy patients with spinal cord injuries, forty who had suprapubic cystostomies have been, or are being, placed on urethral drainage which has enabled seventeen of them, so far, to empty their bladders by voiding with little, if any, residual. Urethral catheters caused complications such as peri-urethral abscesses in six cases and epididymitis in four cases of the total of thirty-eight urethral indwelling catheters. Urinary infections have been predominantly due to gram-negative organisms and formation of bladder calculi was high. Renal calculi were found in eight of the total seventy, mostly among the forty-three seriously injured patients whose physical activity has been limited.

#### CONCLUSIONS

Patients with spinal cord injury, who have had suprapubic cystostomy for transportation purposes overseas, should be given a chance to re-establish some form of voiding through the urethra.

This is done by inserting a urethral catheter of small calibre, and instituting tidal drainage.

The complications of urethral catheter, such as periurethral abscesses with fistula formation and epididymitis, can be partly reduced by avoiding the use of any catheter over #18 French in size. The patient's condition must be good, before the change from suprapubic to urethral drainage is made. The end result of a good percentage of voiding patients would seem to justify this course of action.

Urinary infections can be controlled by sulfonamides, penicillin, and the new anti-biotics which help to destroy gram-negative organisms.

Urological complications of the upper urinary tract must be expected and constant watch kept for renal calculi and abscess formation. These are treated in the most conservative fashion.

The urological management of the paralyzed patient is a constant struggle

against many odds, but the end result of a voiding, upright, infection-free individual is worth the fight.

LT. COLONEL FRANK MAYFIELD: We will now have the next paper, "Associated Complications in War Wounds of the Spine" by Captain William C. Ward and Major G. L. Maltby.

CAPTAIN WILLIAM C. WARD: Since the opening of Ashford General Hospital in November 1942, there have been eighty-eight patients admitted with injuries of the spinal cord and cauda equina. Of these, twenty-three were ambulatory on admission and represented concussion of the spinal cord and injuries to the cauda equina; these cases required no special treatment and were soon discharged from the service per certificate of disability. The remainder were admitted as litter cases, consisting of disabling concussion of the cord, complete and partial severances of the cord, and cauda equina injuries. Before the decision was made to retain these cases in the Army General Hospitals, until maximum recovery and readjustment had been reached, they were being transferred to the Veteran's Hospitals in spite of their usual complications of decubitus ulcers and urinary tract infections. However, since that time these patients have remained and appear to have benefited. At present there are thirty-two cases being cared for jointly by the neurosurgical and genito-urinary sections. The entire group had, in addition to the usual decubitus ulcers and urinary tract pathology, associated injuries to the peripheral nerves and peripheral blood vessels, compound fractures, traumatic amputations, penetrating wounds of the chest and penetrating wounds of the abdomen requiring colostomy. It is not the purpose at this time to discuss these associated conditions if uncomplicated by infection. Many of the patients with injury in the region of the cauda equina complained of severe pain in the lower extremities which appeared to be similar to causalgia and have not responded to any of the usual treatments. Spastic disorders in the complete and near complete cord lesions have likewise been quite a problem. These complications, however, will not be considered at this presentation.

The following cases represent the less common problems that existed, or have appeared in the group of cases that are now in the hospital:

CASE I (In italics) Fecal Fistula through the spine. (End of italics)

M. H., Pfc, was admitted to the Ashford General Hospital on 11 October 1944. On 6 July 1944 this patient sustained a shell fragment wound of the spine in the region of L-5. On 7 July 1944 a laparotomy was done. The amount of injury to the intestines is not described; however, he had generalized peritonitis at the time. A cystostomy was done for rupture of the bladder. The wound in the region of the lumbar spine was debrided. Postoperatively the patient had quite a stormy course. Later he was found to have drainage of fecal material through the wound in the lumbar region. He also had drainage of feces and urine from the suprapubic tube. On 29 July 1944 an exploratory laparotomy was done, and a loop of small intestine was found to communicate with the bladder. The source of drainage of feces through the wound in the back was not found. Postoperatively the patient did very well. However, the upper end of the abdominal incision opened and drained fecal material but no urine.

Physical examination on admission to this hospital revealed a chronically ill patient. There was a midline abdominal incision with drainage of fecal material and pus from the lower portion. There was an extensively scarred wound measuring 3 x 4 cm. in the midline of the back at the level of the second lumbar vertebra. Immediately beneath this scarred area was an area of fluctuation and pressure on this caused purulent material to be expressed from the wound. There was marked atrophy of all of the muscles of both lower extremities. However, the patient was able to move the toes of both feet a little. There was an area of anesthesia over both buttocks and the posterior aspect of both thighs. On numerous occasions the patient had noted the passage of gas through the draining wound in the lumbar region. On 4 December 1944 a barium enema was done, but considered unsatisfactory. The film showed what appeared to be a fistulous tract extending from the distal portion of the sigmoid superiorly into the region of the 4th lumbar vertebra. On 5 February 1944 the draining sinus was injected with lipiodol. This revealed the sinus to extend into the 5th lumbar interspace and to proceed through the sacrum to enter the intestinal tract. Films made one hour later revealed oil in the sigmoid. On 15 March 1945 two small pieces of bone extruded from the wound in the back. He continued to have a considerable amount of purulent



drainage from this wound in addition to gas. On 7 April 1945 a transverse colostomy was done. There has been less drainage from the wound in the back since that time; however, the patient does continue to pass a small amount of gas occasionally through this wound. Further exploration is now considered.

CASE II (*In italics*) Fecal fistula through spine (*End italics*).

L. C., Pvt, was admitted to Ashford General Hospital on 17 April 1945. On 26 December 1944 this soldier sustained a shell fragment wound of the back in the region of the 1st and 2nd lumbar vertebrae. On 27 December 1944 a laminectomy was done from D-12 to L-3. An extremely large foreign body was removed from the body of L-2. The dura was widely torn and the bodies of L-2 and L-3 were severely comminuted. There were two roots of the cauda equina intact, and a dural repair was accomplished with fascia. Postoperatively the patient was quite ill and had an ileus. On 3 January 1945 the laminectomy wound was aspirated; gas and pus were obtained. The laminectomy wound was then opened and packed with gauze. On 4 January 1945 an ileo-transverse colostomy was done because of drainage of feces from the laminectomy wound. Following this the drainage from the wound subsided some.

Physical examination on admission to this hospital revealed a chronically ill patient. There is a rather extensive right rectus incision which is well healed, and an extensive laminectomy wound which extends from about D-12 to L-4. There was a small amount of four drainage from this wound and a small pack was in place. When the pack was removed there was a small granulating cavity. There did not appear to be a sinus tract leading from this.

While in the hospital there has been noted no passage of gas or feces from the wound in the back. There is very little drainage from this wound at the present and it is closing satisfactorily. A barium enema has been attempted and was not successful.

CASE III (*In italics*) Urinary fistula through spine (*End italics*).

M. K., Pfc, was admitted to the Ashford General Hospital on 3 October 1944. On 1 June 1944 this soldier sustained a shell fragment wound of the spine in the region of L-5 with immediate paralysis of both legs and a rigid abdomen. Exploration revealed a large retroperitoneal hemorrhage. A pyelogram, done later, revealed an injury to the left ureter. On 25 July 1944 an exploration was made of the left ureter and a foreign body was removed. A catheter was inserted into the ureter.

Physical examination on admission to this hospital revealed several draining wounds over the back in the region of the 5th lumbar spine. There was a complete paralysis of the entire right lower extremity; however, the patient showed some function of the left quadriceps muscle. The patient stated that there has been urinary drainage from the wound in the back.

A short time after admission to the hospital, the patient had an intravenous pyelogram which did not reveal any definite injury to the left ureter. Following this the patient's general condition gradually improved. Most of the wounds on the back healed. However, one small area continued to drain purulent material and intermittently drained urine.

On 10 February 1945, the sinus was injected with lipiodol. The sinus tract passed down through the left sacro-iliac joint and proceeded to enter the left ureter near its distal end; the oil then ascended the ureter to the level of the 4th lumbar vertebra. Films made twenty-four hours later showed a small amount of oil in the left kidney and in the bladder. Intravenous pyelogram was repeated on 14 February 1945 and this revealed a small stone in the ureter apparently at the site of fistula. Urine continued to drain from the sinus and could be demonstrated by methylene blue given by mouth.

On 14 March 1945, the left kidney was removed. There was no further drainage of urine from the wound in the back. However, there persisted some drainage of pus. On 2 May 1945, the sinus tract was explored and several small fragments of bone removed.

CASE IV (*In italics*) Biliary fistula (*End italics*).

H. LaC., Sgt. was admitted to Ashford General Hospital on 17 January 1945. On 17 October 1944 this soldier sustained a bullet wound of the abdomen and spine, resulting in immediate paralysis of the lower extremities. On 18 Oct 1944 a laparotomy revealed a large laceration of the right lobe of

the liver. This was packed and drained through a stab wound in the right upper quadrant. A spinal tap was done which revealed bloody fluid but no block. On 4 November 1944 a laminectomy was done. The spinal cord was found to be partially severed. During the month before admission the patient vomited after each meal and there was persistent drainage of bile and purulent material from the sinus on the abdominal wall.

Physical examination on admission to this hospital revealed an acutely ill patient with paralysis of the lower extremities. There are multiple decubitus ulcers over both hips, buttocks, sacrum, both legs and both heels. There is a small draining sinus in the right upper quadrant immediately beneath the costal margin. Pressure over the lower portion of the right chest caused a flow of considerable amounts of purulent material and bile. There was a well healed laminectomy wound over the lower dorsal spine. There was complete anesthesia below the level of D-12, and complete paralysis of the lower extremities. X-ray of the chest on 23 January 1945 revealed elevation of the right diaphragm. On 5 February 1945 the sinus in the right upper quadrant was injected with lipiodol. This revealed an abscess tract along the lateral border of the right lobe of the liver which measured about 15 x 1 1/2 cm. Some of the oil entered a small bile duct and reached the common duct. On 11 April 1945 the draining sinus was opened for a distance of about 1 1/2 inches and a drain placed in. Since that time the patient's condition has continued to improve.

CASE V (In italics) Osteomyelitis of the spine. (End of italics)

E.P., S/Sgt., was admitted to the Ashford General Hospital on 16 September 1944. On 7 July 1944 this patient sustained a shell fragment wound of the spine in the region of L-5. The abdomen was explored and a large perforation found in the posterior wall of the ascending colon. Exteriorization and ileostomy was done. There developed a large amount of foul drainage from the wound in the back. On 4 August 1944 the patient developed quite high temperature and was acutely ill. Exploration of the lumbar wound was carried out and no retroperitoneal abscess was found. Efforts to control the patient's pain were unsuccessful and on 17 August 1944 a bilateral cordotomy was done in the region of D-4 and D-5.

Physical examination on admission to this hospital revealed an extensive wound in region L-4 and L-5 measuring 5 cm. in diameter. Free bone could be seen in the depths of the wound. There is a moderate amount of foul purulent drainage from this wound. There was a flaccid paralysis of the lower extremities. Patient failed to gain weight and had irregular elevation of fever always associated with a considerable increase in drainage from the wound on the back. The only complaint was loss of appetite.

Examination of the abdomen revealed a bulging mass in the right lower quadrant. Pressure on this mass caused a small amount of purulent material to extrude from the wound in the lumbar region. On 9 January 1945 an incision and drainage of the abscess, in the right lower quadrant, was done. This was carried out through the retroperitoneal space. Within four weeks the wounds in the lumbar region healed. However, the wound in the right lower quadrant has persisted in draining until the present. On 1 May 1945 the draining wound in the right lower quadrant was injected with lipiodol and was found to enter a small abscessed cavity, just medial to the wing of the ilium. A small amount of oil also passed through an opening in the bone and into the region of a large retained foreign body in the right buttocks. There was no extension of the abscess into the region of the spine at the present time.

CASE VI (In italics) Osteomyelitis of the spine; abscess of psoas muscle.

( (End of italics) E.P., Pvt., was admitted to Ashford General Hospital on 20 January 1945. On 14 September 1944 soldier sustained a shell fragment wound of the back just to the left of the third lumbar spine. On the same day a laparotomy revealed a wound of the ascending colon; exteriorization of the ascending colon was performed. The wound of the back was debrided. On 4 October 1944 a debridement of the wound in the lumbar region was carried out with closure of the dura. On 4 November 1944 the lumbar wound was again debrided and several bone fragments were removed which revealed acute osteomyelitis.

Physical examination on admission to this hospital revealed a colostomy in the right lower quadrant. There is a laminectomy wound on the back over



the 2nd, 3rd, 4th, and 5th lumbar vertebra. The wound was not well healed and drained a small amount. There was complete paralysis of the right lower extremity; very weak motion could be accomplished with the left lower extremity. Because of the persistent draining lumbar wound, this sinus was injected with lipiodol. This revealed a large abscess cavity in the right psoas muscle at the level of the 4th and 5th lumbar vertebrae. On 11 April 1945 a retro-peritoneal approach was made and the abscess in the muscle could not be located. On 30 April 1945 the draining sinus in the back was opened. Three small sequestra were removed. The sinus tract extended into the bodies of L-4 and L-5. No further fragments of loose bone could be obtained. It was thought that this procedure had at least afforded better drainage. X-ray examination reveals osteomyelitis of the bodies of L-4 and L-5 vertebrae.

CASE VII (In italics) Foreign body with abscess. (End of italics)

T.O.B., Pfc, was admitted to Ashford General Hospital on 27 January 1945. On 8 August 1944 this patient sustained a shell fragment wound of the back in the region of the first lumbar vertebra. He had immediate, complete paralysis of the lower extremities. A spinal tap revealed bloody spinal fluid, but no block. The wounds were debrided. The wound of entrance in the back has intermittently opened and drained purulent material since injury.

Physical examination on admission to this hospital revealed a small, draining wound just to the left of the first lumbar spine. Neurological examination revealed a complete paralysis of all of the roots below L-1. Patient remained afebrile and was able to be up in a wheelchair shortly after admission. The general condition of the patient improved, but there was persistent drainage of purulent material from the small wound over the left 12th rib. X-ray examination in this region revealed no evidence of osteomyelitis. On 29 March 1945 the draining sinus was injected with lipiodol. There was a small abscess cavity of about 4 x 3½ cm. in the subcutaneous and muscle tissues of the back about 5 cm. to the left of the midline at the level of the first lumbar vertebra. On 24 April 1945 this small, draining sinus was opened and a vaseline pack, about 3 cm. in diameter was removed. The wound is rapidly closing.

CASE VIII. (In italics) Foreign body with draining sinus) (End italics)

L.R., Pfc. was admitted to Ashford General Hospital on 11 March 1945. On 2 November 1944 this soldier sustained a shell fragment wound of the spine in the region of L-5, resulting in immediate paralysis of the lower extremities. On 3 November 1944 a laminectomy was done, and a foreign body removed. Most of the cauda equina appeared to be intact and only two roots on the right were actually severed. On 6 November 1944 the patient showed evidence of meningitis and was given penicillin intrathecally. He continued to run some temperature until about 24 November 1944 and there was a moderate amount of purulent drainage from the wound. There had been continued improvement in motion of the lower extremities since the injury; however, drainage from the wound was persistent.

Physical examination on admission to this hospital revealed a laminectomy wound which extends from L-4 to S-2. There was a small area about ½ cm in diameter near the center of this wound which was still draining. There was an area of anesthesia over both buttocks. The patient was able to accomplish all motion of the lower extremities weakly, and was able to walk without the aid of crutches. On 20 April 1945 the sinus tract was injected with lipiodol. This was found to extend into the soft tissues immediately posterior to the neural canal. On 30 April 1945 the sinus tract was explored and a rubber drain about five inches long found in a small abscess pocket in the region of the sacral canal. The wound is healing.

CASE IX (In italics) Periarticular calcification. (End of italics)

A.C., Pvt., was admitted to Ashford General Hospital on 7 January 1945. On 18 November 1944 this soldier sustained a shell fragment wound of the spine at the level of D-10, resulting in immediate, complete paralysis of the entire body below this level. A spinal puncture was done which revealed a complete block, but it was thought that laminectomy was not indicated. There was no improvement in the paralysis or anesthesia since injury.

Physical examination on admission to this hospital revealed a small, well healed wound about 1 cm. in diameter just to the left of the spinous process of D-10. There is a complete paralysis of all of the muscles below the level of D-11, and anesthesia below this level. There is marked pitting edema of

both lower extremities and extensive decubitus ulcers over the hip and sacrum. X-ray examination of the knees and hip revealed dense calcifications in the soft tissues about both knees. There is likewise erosion of bony substance over the greater trochanters. There are cystic areas of bone destruction, approximately 2 cm in diameter, in the upper portion of the shaft of the left femur. There has been only slight improvement in this patient's condition while in the hospital.

CASE X (In italics) Chronic recurrent meningitis. (End of italics)

J.L.P., Pvt., was admitted to the Ashford General Hospital on 17 January 1945. On 19 November 1944 this soldier sustained a shell fragment wound of the spine in the region of L-3. The entrance was 5 cm to the left of the spine. He had immediate, complete paralysis of the lower extremities. A laminectomy was done and a small shell fragment was found lying along side the cord with laceration of the third lumbar root. Postoperatively the patient was able to move the feet and legs a small amount. He developed a spinal fluid fistula at the site of the original wound. On 16 December 1944 the spinal fluid drainage stopped, and the patient became quite ill with high temperature (104), stiff neck, and rapid pulse. A spinal puncture was not done at this time and patient gradually improved. Patient stated that he had been running a low grade fever and had had frequent severe left frontal headaches since middle of December.

Physical examination on admission to this hospital revealed a small, well healed wound just to the left of the spine in the region of L-3. There was a well healed laminectomy wound which extended from L-1 to L-3. There were weak contractions of both quadriceps muscles. No other motor function was noted. There was hypesthesia over both lower extremities below the level of L-2 dermatome. There was an extreme degree of emaciation. On 29 January 1945 an intravenous pyelogram revealed slight hydronephrosis of the right kidney; the left kidney was completely blocked. It was thought that the persistent fever and extreme emaciation was due to this. On 31 January 1945 the left kidney was removed and found to contain thick pus and abscesses. Postoperatively the patient felt much better and appeared improved. Ten days later he developed sudden onset of severe left frontal headache. This was associated with a rise in temperature to 103. On the next day the patient continued to have a temperature of 103, associated with a stiff neck. A spinal puncture was done which revealed a white cell count of 4,408; 99% polys. Culture of the spinal fluid was negative. During the next two days the temperature subsided. Two days later a spinal puncture revealed a white cell count of 800 and culture revealed bacillus pyocyaneus. The patient's condition gradually improved. On 15 March 1945 the patient developed a temperature of 104, became irrational with a pulse of 160, and appeared critically ill. The spinal fluid revealed 2000 white cells. The next morning the patient's temperature was 99; he was rational, and appeared greatly improved. On 26 March 1945 the patient had a similar episode of headache, slight fever, and stiffness of the neck. X-ray of the lumbar spine revealed no sequestrum. Under local anesthesia on 26 April 1945 a small area of the laminectomy wound was opened. The epidural fat was edematous, but no pockets of pus were found. A drain was placed in the extradural space. Since that time the patient has shown slight improvement but has had one mild attack of headache associated with fever. It is hoped that his condition will improve sufficiently to permit any further indicated surgery.

The cases presented represent uncommon complications as found in eighty-eight cases of spinal cord and cauda equina injuries.

Injection of draining sinuses with lipiodol has helped in determining the extent of the cavities, their locations, and frequently the indicated treatment.

LT. COLONEL FRANK MAYFIELD: These two papers are now open for discussion.

Discussion on paper presented by Captain William C. Ward, Ashford General Hospital, on "Complications and Causes of Death," and paper presented by Captain Boris Petroff, Newton D. Baker General Hospital, on "Urological Aspects."

COLONEL IRVING HINS GAGE: The two urological complications that we have seen are infection and stone formation. The majority of all these cord cases have urinary infection of varying degrees with several types of bacteria,



both cocci and bacilli, proteus being one of the most difficult to handle. However, the urologists have accomplished excellent results in treating these cases, and their treatment in its various phases is established upon sound urological principles. Urinary calculi, however, is a serious menace to these cord cases. About 20% of the cord cases in our three Neurosurgical Centers in the Fourth Service Command have kidney, ureteral or bladder stone formation.

It has been repeatedly demonstrated that recumbent patients develop urinary calculi. This is due to increased absorption of osseous calcium and its excretion. It has been demonstrated by Flock that calcium phosphate is precipitated out in the kidney in a similar manner as the sulfonamides. Flock stated that by repeated X-ray examination, one could find early precipitation in the calyces. He reported cases where he had demonstrated early precipitation of calcium and had removed same by washing out the kidney pelvis with 1/4% acetic acid solution. I feel confident that we are having the same calcium precipitation in our cord cases and should take steps for their early recognition and treatment. We have established a routine regimen mobility, diet and copious fluid intake. However, I would recommend that repeated X-ray examination of the urinary tract of the cord cases be done, from their arrival to their discharge. This should also apply to the Orthopedic Services in the cases of prolonged immobilization of the patients with fractures. If we do this I believe stone formation and its sequelae can be prevented.

A most interesting observation in these cord cases is that even though they have all of the environmental requisites for the development and propagation of phlebothrombosis, there has not been a single instance of this complication in over a hundred cord cases in our Command. This is true both from the local and systemic effects of phlebothrombosis. We have had no infarcts of the lung in any of our cord cases. This, to me, is a most interesting observation and should be investigated thoroughly, as it may throw considerable light on this most interesting pathologic phenomenon which is so little understood from the etiological standpoint.

Another complication which is not uncommon is for a simple decubitus ulcer to develop into one which rapidly destroys all of the integument down to the osseous tissue. I have seen the neck of the femur, acetabulum and ilium exposed by ulceration, as well as extensive gangrenous sloughs over the sacrum in these cord cases. I feel that these complications of simple decubitus ulcer are due to the symbiotic relationship between the streptococcus and staphylococcus as recorded both experimentally and clinically by Helenoy. The hemolytic streptococcus that produce skin gangrene as described by Helenoy has been present in a few cases. Therefore, we should suspect either one or both of these clinico-pathologic states when a decubitus ulcer takes on a rapidly spreading destructive process. The energetic treatment of these decubitus ulcers from a bacterologic standpoint with early skin grafting will prohibit ulcer complications and promote rapid healing.

I feel confident that the majority of all complications that occur in these "cord cases" can be prevented.

CAPTAIN HAROLD LIPSCHITZ: I know I can speak for Lt. Colonel Stone and Major Hamm in congratulating Captain Petroff for the fine work he has been doing here. I realize some of the difficult situations that must have arisen, particularly in getting adequate equipment. I want to comment on the use of cystoscopy in treatment of paraplegics at Wakenham General Hospital. We have found that cystoscopy is a necessary procedure. This has been impressed on us because of the great number of cases arriving at our hospital from overseas with bladder calculi present on arrival. Recently, five out of seven cases presented multiple bladder calculi at the time of admission to the hospital. For this reason, we believe cystoscopy should be done as soon after arrival of the patient as is possible, and preferably within 48 hours. There is a point that should be stressed concerning the time of removal of all catheters. Cystometric readings, although valuable, cannot be depended on, because the most important factor is the presence or absence of spasm of vesical sphincters. When the sphincters are fully relaxed, the Cunningham incontinence clamp suffices for urinary control. In the presence of good detrussor function, accompanied with refractory spasm of the vesical sphincters, it is possible that electric destruction of the sphincteric control will be the answer. I would like to ask one question of the neurosurgeons: We have always been taught that automatic bladder function or voluntary bladder



control cannot be attained in the presence of destruction of the third sacral nerve supply to the urinary bladder (Nervi Erigentes), yet our best results with return of voluntary bladder control have been in those cases of recovering partial paraplegia where these nerves have been damaged. Will the neurosurgeons please explain?

LT. COLONEL CONDUCT W. CUTLER: Urological Aspects - All cases except one have shown flaccid type of bladder paralysis on admission. Eighty percent have shown no bladder or rectal sensations. The vast majority of cases are now appearing with suprapubic bladder draining. Only three cases with perineal indwelling catheters. Of sixty-seven cases, forty-two have had suprapubic tube drainage, twenty urethral indwelling catheters, two had catheters through a perineal urethrotomy and three no catheters at all. The suprapubic drainage cases closed spontaneously. In two of these urethral catheters were substituted for a short time. The perineal urethrotomy cases closed spontaneously after removal of the catheter. Two of the twenty indwelling urethral catheter cases had developed periurethral abscesses requiring suprapubic cystostomy. Only two of the sixty-seven cases have had full return of normal bladder function. The remainder have automatic bladders which empty periodically approximately every hour to one hour and a half. These patients have little or no control. Three cases admitted without catheters were found to have distended bladders with residual of 300 to 400 cc. and one with overflow and incontinence.

Tidal drainage treatment was instituted for the cases with suprapubic drainage in which the wound was fairly tight around the tube. Following a week of sulfadiazine by mouth and boric irrigation, mandelic acid salt (calcium mandolate) by mouth and acetic acid solution for tidal drainage were used in the earlier cases. A large number of cases, however, tolerated this regime poorly. The present plan, which is more effective, employs boric acid solution five-tenths percent for tidal drainage. Sulfadiazine is used one gram four times daily for seven days, with a similar quantity of sodium bicarbonate. Fluid intake is kept at 3,000 cc. as long as tidal drainage is used. If sulfadiazine is not well tolerated, twenty-five thousand units of penicillin is given every three hours until the infection is under control. Continuous drainage with irrigation is used in those cases in which the suprapubic sinus is wide open and for those who do not tolerate tidal drainage well. The irrigating solution is 1 to 8,000 potassium permanganate. No complications other than a rare pyelonephritis have been observed. These cases have been fewer under the present system than when the mandelic acid therapy was employed. Four cases in which indwelling catheters through the urethra had been used developed epididymitis.

Conclusions: That indwelling urethral catheters in these cases are undesirable because of complicating infections and epididymitis. Bladder function has not returned more rapidly where urethral catheters have been employed than with suprapubic drainage. Drainage through perineal urethrotomy wound has proven satisfactory in that it provides a good drainage and is not associated with complications. Such wounds have closed rapidly after removal of the catheter. The number of cases in this group has been too small to draw conclusion. Tidal drainage has succeeded, where appropriate, in keeping the bladder clean and free of infection. It has been the general observation that the development of automatic bladders is rather slower in these paraplegic cases than in civil practice. It has been proposed that better and more rapid results might attend the use of a perineal urethrotomy with indwelling catheter permitting the secondary surgical closure of suprapubic cystostomy wounds, once infection has been controlled. It is believed that the automatic bladder would develop more rapidly under these conditions.

CAPTAIN G. BAUMHARTER: Captain Petroff has made a very complete summary of the urological complications of spinal cord cases. I would like to discuss some of our results on these cases from my services at the Gardiner General Hospital and the Hines Veteran Hospital in Chicago.

I would first like to show an unusual complication in one of these paralyzed cases resulting in death. The bullet that transected the spinal cord, also cut the right uretero-pelvic junction and lodged in the diaphragm. Shiodan injected into the bladder refluxed back up into both kidneys explaining his pyelonephritis. Dye injected into the right flank fistula



showed extravasation into the right flank and made a pyelogram of the right kidney. Both trochanters were protruding through his large hip ulcers. Excision of these made nursing care easier, but his course was rapidly downward and he expired in spite of penicillin, plasma, blood transfusions and sulfa drugs. The new information that we have now regarding the large amounts of serum protein loss from these bed sores may be the factor in prolonging the lives in similar cases and preventing this severe emaciation that too often occurs in these cases with large bed sores.

We do not use tidal drainage. We use a closed system of bladder lavage set up with a special two way clamp. It is fool-proof, simple and needs no specialized care. It can be easily taken care of by both patient and nurses. Simple pressure of the fingers allows bladder to be filled, release of the pressure allows fluid to run out of the bladder. The height of the urinary drainage tube can be elevated to the level of the bladder, thereby keeping a certain amount of dilating fluid in the bladder in those cases which are extremely spastic.

We believe by this technique to be able to correct the spastic and small capacity bladder so that when automaticity does set in, the bladder will have a bigger capacity and be more elastic.

We use a cystometer which registers full bladder pressure and volume simultaneously. It has been our experience that those bladders with 100 to 150cc volume that can exert a pressure of over 40mm Mercury pressure either reflexly or by intra-abdominal pressure, will successfully empty to a low residual and need no further catheter drainage.

We find that urethral catheters get along about as well as suprapubic and sometimes better if the suprapubic catheter leaks, providing the urethral catheters are changed frequently and kept clean and irrigated. Otherwise, of course, if neglected peri-urethral abscesses are common.

For the most part, the cystostomy tubes inserted overseas are properly placed and located and fit well. However, those very few that were found unsatisfactory were so because of three reasons:

(1) Too low an insertion in the abdominal wall, causing pressure of tube against symphysis pubis with, of course, the potential danger of bone involvement.

(2) Too low an insertion in the bladder itself, causing pressure of the end of the catheter against the trigone which often produces spasm and discomfort and, lastly,

(3) Lack of support of the bladder to the rectus muscle causing a false pocket of urine between bladder and abdominal wall, making replacement of the suprapubic catheter very difficult.

This problem of spinal cord injuries is one of the few problems of World War II and one which is a challenge to almost every medical specialty. We will all have to learn from the other's experiences. Therefore, meetings of this sort are most valuable to all of us.

CAPTAIN JAMES H. STEANS: At McGuire General Hospital we have over thirty paraplegic patients with catheters in place. Twenty of these have suprapubic drainage.

I would like to make two remarks about suprapubic cystostomy. First, suprapubic cystoscopy has proved to be a valuable procedure. By passing the cystoscope through the suprapubic tract, it is possible not only to examine the interior of the bladder, but also to remove encrusted mucosa and stones. Our impression is that the patient has less cystoscopic reaction than by the transurethral route.

The second remark concerns the drainage of the bladder with suprapubic catheter. This has been improved a great deal by rolling the patient on to his abdomen - while irrigating the catheter. The gravitation of the exudate toward the suprapubic catheter facilitates its removal. In the supine position only the supernatant exudate is removed.



I can see a problem - namely, whether or not it is preferable to allow the sinus tract to close early and to treat the bladder transurethraally or to treat the bladder suprapubically until it is permanently free of exudate and stones, and then to allow the sinus tract to close, reasonable expecting to have no more difficulty afterward.

LT. COLONEL FRANK MAYFIELD: I hate to close the discussion on such an important subject as the bladder. Captain Petroff -

CAPTAIN BORIS PETROFF: I would like to answer Colonel Gage about thrombophlebitis. We have two cases - one came from overseas with a terrifically big thigh; the other had a swollen leg which was assumed to be thrombophlebitis. I am surprised that there has been no question of suprapubic cystotomies, because when these patients first came in with suprapubic tubes in them, it was mainly on Major Elkins' suggestion that they were changed from suprapubic to urethral drainage. Major Elkins did a firm bit of insisting. I was all for leaving the suprapubic tubes in but Major Elkins said to go ahead with the removal of suprapubic tubes. We made the change, the first patient developed epididymitis, and Major Elkins said to let it stay in - that it wouldn't hurt him. He is now one of our prize patients, voiding with an automatic reflex bladder. Now for this business of peri-urethral abscess, we end up with a fistula and when the patient begins to void, everything runs out over the floor like a watering can. This is a great problem to us, and I would like the visiting urologists to suggest some way of repairing this peno-scrotal type of fistula.

LT. COLONEL FRANK MAYFIELD: The next two papers by Captain Barker and Captain Harper will be presented as a group and then discussed if time permits. It is necessary in deference to our hosts that we close this meeting by 5:15. I now call upon Captain Barker whose subject is, "Surgical Treatment of Decubitus Ulcers."

CAPTAIN DONALD E. BARKER: A review of previous literature reveals little success in the surgical treatment of bed sores. Monroe in a personal communication stated skin grafting had been tried in those without success. Lemon and Alexander<sup>1</sup> have reported one case of back ulcer treated by incision and closure. The type of patient dealt with in this paper besides being a problem of bed ulcer is also one in which there is complete or partial denervation to the area affected by the ulcer. There are two questions which came in mind at the start of the work. (1) Whether the ulcer could be closed or grafted with success, and (2) whether donor sites would heal after surgery. This paper presents results of a series of 30 operations done at this hospital.

Most of the paralyzed cases were admitted with one or more bed sores. Of the 21 patients in this series, 10 or 50% had only 1 ulcer. 5 or 25% had 2 ulcers, 4 had 3 ulcers, and one case had 5 ulcers. The ulcers ranged in size from 1 x 2 inches to 6 x 8 inches, covering the entire area over the sacrum. Seven cases had ulcers over one or both hips.

#### Pre-Operative Management

As soon as a definite line of demarcation became apparent, the necrotic tissue was dissected away with a pair of scissors. From that time until grafting the ulcers were dressed with either boric ointment, urea ointment, or an emulsion made by mixing 4 cc. penicillin in 1 oz. of vaseline. The appearance of the ulcer was not affected greatly by the type of ointment used. When the ulcers had a clean base, the operations were done. No attempt was made to get areas bacteriologically clean.

#### Operative Procedure

Split thickness skin grafts, 12/1000 of an inch in thickness, were used on 16 cases. The granulating area was shaved down to a yellow base when possible and the graft sutured into place. In a number of cases the ulcer was so close to the bone that no incision of the granulation tissue was possible. All of the cases received wet dressings for 4 days post operative. The principle problem met here was the inability of the patients to remain in one position for any period. In the constant changing of position by the ward personnel the dressings were moved about and accounted for the loss in some grafts. One patient with five large sores was grafted three times with-



out success. His daily protein loss from the sores was 50 gm/day, and there was reversal of the A/G ratio.

50% of the cases were healed after the first operation. 40% had a take of about 50% of the graft, and there were 3 complete failures. The apparent poor results of the grafting can be attributed to the debilitation of the patients concerned. One fourth of the cases had ulcers 4 x 8 inches or larger.

(R.D.) Plate 1 shows preoperative ulcer 6 x 8"; plate 2 shows same ulcer 14 days postoperative. Plate 3 shows same ulcer 2 months postoperative. Plate 4 shows another healed graft 5 months postoperative. (Deriv.)

Seven primary closures were done by excision of the scarred area and closure of the skin edges with 000 silk suture. Only the smaller ulcers were closed by this method. All over 4 inches in diameter were closed by grafting or rotation flaps.

Of the seven cases, 5 healed after one operation. Two of the seven cases opened up partially after the seventh day postoperative. Some of these cases have been healed five months to date and withstand trauma well. In no case did infection apparently play any part.

(SA) Plate 5 shows a bed sore pre-operative. Plate 6 shows same patient four months postoperative. (St) Plate 7 shows pre-operative ulcer, plate 8 shows same ulcer postoperative.

Rotation flaps were used in five cases of ulcers of the hip. It was observed early that the rotation of the hip when the foot moved caused a tearing along the suture line of closures of the hip and cases in which grafts were used. These cases were closed by rotation of the full thickness flap of skin from the adjacent area to the ulcer, and either closure of the donor area by grafting with split skin graft or extensive undermining and closure.

(AP) Plate 9 shows ulcer of the hip pre-operative; plate 10 shows same ulcer immediately after closure; plate 11 shows ulcer four weeks postoperative. (BA) Plate 12 shows hip ulcer pre-operative; plate 13 shows same ulcer 3 months postoperative.

### Discussion

A total of 30 cases have been operated on to date. Sixteen of these were skin grafts; 7 primary closures, 2 operations by basket weaving, and 5 operations by rotation of a flap. Of the 30 cases, 19 or 63% are healed at the present time. 27% of the ulcers have about 50% closure and out of the 30 cases there were three complete failures.

In the rotation flap and the primary closure series the results were better than those in which split grafts were done. This probably due to the fact that the split skin grafts were used in large ulcers and also in cases in which the condition of the patient seemed too poor to permit extensive radical surgery. Of the primary closures and rotation flaps 80% healed after the first operation.

The following types of closures are recommended:

In large ulcers of the back; i.e., those measuring about 4" in diameter and also in cases in which there is extreme debilitation, split thickness skin grafts is the method of choice. In small ulcers measuring from 1 to 3" over the back the method of choice is excision of the ulcer and closure at the time of operation.

In ulcers of the hip, skin grafting is not recommended. Even in the smaller ulcers of the hip it is recommended that a rotation flap be done. In ulcers from 1 to 2" in diameter a rotation flap with primary closure of the donor area is the method of choice. In large ulcers a large rotation flap to the ulcer area with split thickness skin graft of the donor area should be used.

It is estimated that the time saved in these ulcers varies from six months to two years, and in some of the larger ulcer areas it is probably a life saving measure to use split thickness skin grafting.

An ulcer about 1" in diameter may take six to nine months to heal, whereas, ulcers of the back such as some shown in this series without surgery would probably not be healed after five years. I believe that the excision inclosure of even as small ulcers as three-quarters of an inch in diameter that have penetrated to the subcutaneous tissue should be done.

The following conclusions are presented:

1. Primary excision and closure of small ulcers of the back is the method of choice.
  2. In large back ulcers or in patients who are very poor risks surgically skin grafting is successful and the recommended method.
  3. In hip ulcers a rotation flap is a quick method of a permanent closure.
- (1) Lamon, John D., Jr., Lt. Col., MC, and Alexander, Eben, Jr., Capt., MC, Secondary Closure of Decubitus Ulcers with the Aid of Penicillin. J.A.M.A. 127:396 (Feb) 1945

LT. COLONEL FRANK HAYFIELD: The next paper is entitled, "The Nutritional Aspects of The Care of The Paralyzed Patient", presented by Captain Harold A. Harper, SMC., Nutrition Consultant, Fifth Service Command.

CAPTAIN HAROLD A. HARPER: It is now becoming well recognized that malnutrition may readily occur as a result of disease or injury. In addition to inadequate food intake there are various factors which decrease the efficiency of utilization of ingested food while increasing the rate of destruction of stored energy in its various forms. When the patient is in a satisfactory nutritional state at the time of the injury or operation, a relatively brief period of starvation or malnutrition is probably of no serious consequence. This is very definitely conditioned however by the state of the individual's reserves. The cases with which we have to deal are for the most part those who have been wounded in overseas combat theatres. Their nutritional history during the period immediately preceding the injury is frequently characterized by a period of subsistence on combat or emergency rations and difficulties of supply and transport may have resulted in an impaired food supply. Although the rations in use are nutritionally adequate, various environmental factors may result in the consumption of a diet which is only borderline. It is reasonable to assume therefore that many men have a diminished nutritional reserve at the time they sustain their injury. Accelerated depletion of these reserves enhanced by the anorexia secondary to surgical procedures may therefore be sufficient to produce an acute malnourished state.

The paralyzed patients illustrate well the phenomena described. The majority of such patients have lost a considerable amount of weight, particularly in the atrophic paralyzed extremities. Many also present evidences of generalized emaciation. The nutritional deficiencies of these patients are obviously due to a number of factors. On admission to hospitals in the zone of interior nearly all have large, oozing, decubitus ulcers which are a source of considerable loss of protein. Infection is a common complication with the result that depletion of reserves is accelerated.

It is most important therefore that immediate attention be directed to an evaluation of the state of nutrition of these patients and that methods for correction of the malnourished state and the maintenance of an optimum level of nutrition be instituted.

Attention has been properly focused on the protein nutrition of these patients. As has already been noted protein losses by exudation may be extremely large, - up to 50 grams in some cases. The so-called "toxic" destruction of protein which is concomitant of disease or injury may account for considerable loss and together with the wear and tear quota, one may find that more than 150 grams of protein per day will be necessary to achieve nitrogen balance. Re-establishing and stabilizing protein balance in these cases is usually a rather arduous procedure. It is believed that the situation is complicated by the fact that the underlying injury or pathologic process may markedly influence the mechanisms responsible for blood and tissue protein synthesis.



A study of the blood proteins of these patients frequently reveals increased globulin and decreased albumin levels. This may be the only objective evidence of protein malnutrition but it is to be considered as indicative of extensive depletion of protein stores. It may be presumed that the tissue stores have been called upon to maintain the normal plasma levels as long as possible. As Whipple has pointed out, the tissue proteins are in dynamic equilibrium with those of the plasma, and plasma protein is part of a balanced system of body proteins; a steady state of ebb and flow exists between the plasma proteins and a portion of the cell and tissue proteins.

Recent studies have indicated that there is a definite metabolic partition between the plasma and the rest of the body. Specifically, it is stated that each gram loss of plasma protein is accompanied by a loss of about 30 grams of tissue protein. When regeneration takes place, only 3.5% of the nitrogen retained is used to replenish serum albumin while 96.5% is allocated to replace tissue protein stores. This explains why large quantities of protein may produce relatively little improvement in plasma albumin levels.

Elman has supplied a formula which gives some concept of how large the daily protein intake must be to restore plasma albumin levels to normal.

$$\text{Protein need} = \left( \frac{A - SA}{100} \right) \left( \frac{W}{20} \right) (30) (K_1) (K_2) (d)$$

A = Normal serum albumin concentration in gm. per 100 cc (taken as 4.6).

SA = Actual serum albumin concentration of patient in gm. per 100 cc.

W = Patient's body weight in grams.

K<sub>1</sub> = The reciprocal of the fraction of ingested nitrogen retained.

K<sub>2</sub> = The minimum daily endogenous protein need (usually 25 grams of protein)

d = The number of days in which it is proposed to correct the protein depletion.

Protein need = total amount of protein in grams which must be ingested during the regeneration period of "d" days.

The factor, 20, in the denominator converts body weight into plasma volume, while the factor, 30, represents the ratio between plasma and tissue loss.

A convenient nomogram for computation of the daily protein requirement in hypoproteinemia has been published by the Arlington Chemical Company.

The formula is valid only in cases of chronic hypoproteinemia incident to prolonged dietary deficiency of protein since when hypoproteinemia follows hemorrhage, burns, nephrosis, or liver disease, the 1:30 relationship between tissue and plasma proteins does not hold.

To use a determination of the total plasma protein as a diagnostic aid for assay of the state of protein malnutrition, one must take into account two important factors. For under certain conditions a normal value will be reported when there is actually protein depletion. These factors are (1) the effect of dehydration and (2) the presence of decreased levels of albumin accompanied by an increased globulin. As plasma protein diminishes, the water retaining power of the blood is also decreased. Fluid is lost to the tissue spaces and increased concentration of the plasma will occur with a consequent decrease in total plasma volume. Quantities of protein which would be low in a normal plasma volume would then appear normal or even elevated. Conversely when the concentration of the serum albumin is raised there will be an increase in the plasma volume, averaging about 17-18 cc. per gram of albumin retained. One clinical study reported increases in plasma volume of 600, 800 and 900 cc. in patients receiving 50 grams of albumin. Therefore as one replenishes plasma protein stores there will be a shift in fluid balance so that, for temporary periods at least, an increasing volume will have the effect of reducing the actual concentration of protein.

Again, one may find that total protein is normal but actually there is hypoalbuminemia which is masked by an increase in globulin. This is particularly true where there is chronic infection, most of the increase occurring in the gamma globulin fraction, rich in antibodies. To obviate these pitfalls red cell counts and hematocrit determinations should be obtained simultaneously with the plasma albumin and globulin in order to estimate the probable degree of dehydration. Although much emphasis has been placed on albumin globulin ratios the plasma albumin content is actually the significant factor



involved.

Correction of nutritional deficiencies in these patients may be expected to greatly enhance the success of all aspects of their care. Healing of the decubitus ulcers will be favored as will the success of grafting procedures. As the extensive losses of protein from this source are diminished it will become progressively easier to restore and maintain nitrogen balance. The patient can be expected to more successfully combat the chronic infection to which he is exposed. The efficacy of chemotherapeutic agents will be enhanced and wound healing materially improved.

The basal diet of these patients can ordinarily be the regular high protein diet of the hospital if there is no obvious impairment in their ability to digest or assimilate it. It is obvious that food offered to a patient is of no value unless it is eaten. All too frequently it is observed that no professional notice is taken of the fact that these patients refuse rather large quantities of food. Every effort must be made to assure the serving of a palatable and attractive diet. In some cases it may be desirable to use six smaller feedings per day until appetite is restored. If the diet is properly consumed one can probably depend on a daily nutritional intake of about 2800 calories and 100 grams of protein. From the preceding discussion one notes however that a much larger daily intake of protein will often be necessary to compensate for the losses in exudates as well as those of normal and abnormal metabolism. Additional protein must be allowed for the synthesis and replenishing of body proteins. One should set a protein objective to be obtained daily by these patients - possibly 150 to 175 grams, or more if tolerated. The other components of the diet are depended upon to supply as much energy as possible in order to spare protein to a maximum degree for use in anabolic reactions.

It may be desirable to increase vitamin supplementation. The poly-vitamin capsule ordinarily supplied contains exactly one half the current National Research Council recommendations for the daily intake of the normal adult. The use of two such tablets three times a day should be adequate in the absence of frank deficiency symptoms. Larger doses of the water soluble vitamins are very inefficiently utilized, much of the material being immediately excreted in the urine.

It is apparent that the provision of large quantities of protein becomes a prominent feature of the nutritional management of these cases. Consequently considerable attention has been directed to this problem. In the presence of an anemia most of the administered protein is diverted to the synthesis of hemoglobin and it is not until the anemia has been corrected that satisfactory tissue and plasma protein regeneration will occur. It is of course in these situations that the use of whole blood is of value. To correct an acute deficiency of plasma protein especially where there is frank edema, the administration of plasma or plasma albumin is ideal. But in a chronic hypoalbuminemia due to malnutrition, plasma is of value but may be disappointing. For every gram of plasma protein which remains in the blood possibly 30 grams are removed by the rest of the body. To supply 2000 grams of protein for the entire body requires 30 liters of plasma (120 donors).

From a nutritional point of view it would seem more physiological to supply good quality protein in a more economical and assimilable form. This can be achieved by the use of certain protein concentrates or hydrolysates, several of which are commercially available. Two are hydrolysates of casein, the protein of milk, and are available for both oral and intravenous use. A third is a mixture of wheat, beef, milk, and yeast proteins, for oral use only.

It is usually possible and, in fact, desirable in all of these cases to confine alimentation to the oral route. In addition to the advantage of providing as normal a regime as possible, one must consider the fact that individuals whose plasma protein levels are dangerously low cannot tolerate intravenous fluids with impunity. To administer 100 grams of protein as a five percent Amigen solution, for example, requires the introduction of two liters of fluid. Such a procedure will not be well tolerated if continued for some time.

There is appended a series of recipes for the use of Amigen and Aminoids, as well as certain other formulae which use untreated or natural proteins. The



palatability of Anigen and Aminoids is the principal disadvantage in their use. The relative efficiency of a hydrolyzed over an unhydrolyzed protein in the presence of normal gastric and pancreatic function has not been determined.

It is advisable that patients requiring intensive nutritional care be recommended to the attention of one Dietitian who will be specifically assigned to the task of supplying adequate nutrition to these cases. In the acute phase of malnutrition a daily record of the food intake should be kept. During this period of high protein level should be set and attained. This can be done by judicious use of all the methods at the disposal of the Dietitian. The various formulae suggested may be varied from day to day and administered in such quantities and at such frequency that together with the protein of the basal diet, the protein standards required for the patient will be met. Additional high protein dietary supplements are being developed and will be made available.

The successful application of the principles of adequate nutrition requires constant individual supervision in every case but a sound nutritional plan is all important in the supportive management of these patients if they are to attain maximum benefit from surgical and medical treatment.

#### FORMULAE FOR PROTEIN SUPPLEMENTARY FEEDING

L. AMIGEN FORMULAE (x)						
Formula No.	Ingredients	Am't	C	P	F	Calories
1	Welch's Grape juice	100 gms.	15.1	0.3	--	146
	Lemon juice	10 gms.	1.0	-	--	
	Sugar	10 gms.	10.0	-	--	
	Anigen	10 gms.	-	10.0	--	
			<u>26.1</u>	<u>10.5</u>	<u>--</u>	
2.	Tomato juice	200 gms.	7.2	2.0	0.2	83
	Lemon juice	10 gms.	1.0	-	-	
	Anigen	10 gms.	-	10.0	-	
	Salt	-	-	-	-	
			<u>8.2</u>	<u>12.0</u>	<u>0.2</u>	
3.	Milk	200 gms.	10.0	6.6	8.0	285
	Egg	45 gms.	-	6.0	4.7	
	Sugar	10 gms.	10.0	-	-	
	Anigen	10 gms.	-	10.0	-	
			<u>20.0</u>	<u>22.6</u>	<u>12.7</u>	
4. Custard:	Egg	45 gms.	-	6.0	4.7	210
	Sugar	10 gms.	10.0	-	-	
	Milk	120 gms.	6.2	4.0	4.8	
	Anigen	5 gms.	-	15.0	-	
	Vanilla (tablet)	-	-	-	-	
	Salt, nutmeg	-	-	-	-	
			<u>16.2</u>	<u>15.0</u>	<u>9.5</u>	
5 Junket:	Milk	120 gms.	6.2	4.0	4.8	147
	Anigen	5 gms.	-	5.0	-	
	Junket Powder	11 gms.	10.8	-	-	
			<u>17.0</u>	<u>9.0</u>	<u>4.8</u>	
6.	Prune juice	200 gms	57.6	1.6	-	277
	Anigen	10 gms	-	10.0	-	
			<u>57.6</u>	<u>11.6</u>	<u>-</u>	
7.	Orange juice	200 gms	26.2	1.2	-	154
	Lemon juice	10 gms.	1.0	-	-	
	Anigen	10 gms.	-	10.0	-	
			<u>27.2</u>	<u>11.2</u>	<u>-</u>	

Formula No.	Ingredients	Am't	C	P	F	Calories
8.	Can Pineapple J.	200 gms.	25.6	0.6	0.6	
	Anigen	10 gms.	-	10.0	-	
			25.6	10.6	0.6	150
9.	Milk	150 gms.	7.5	5.0	6.0	
	Choc. Syrup	50 gms.	28.8	2.5	2.5	
	Anigen	10 gms.	-	10.0	-	
			36.3	17.5	8.5	292
10.	Ice Cream	60 gms.	13.5	2.7	7.2	
	Milk	100 gms.	6.0	3.3	4.0	
	Anigen	10 gms.	-	10.0	-	
	Choc. Syrup	50 gms.	28.8	2.5	2.3	
			47.3	18.5	13.7	387
11.	Ice Cream	50 gms.	11.3	2.3	6.0	
	Milk	100 gms.	5.0	3.3	4.0	
	Choc. Syrup	60 gms.	34.5	3.0	3.0	
	Anigen	10 gms.	-	15.0	0	
			50.8	23.6	13.0	415

The Anigen must be dissolved in a warm fluid. In the fruit beverages the 10 gms. of Anigen should be dissolved in  $1\frac{1}{2}$  tablespoons warm water. In the milk beverages, a portion of the milk may be warmed and the Anigen dissolved therein.

## II. AMINOIDS FORMULAE (x)

1. Whole Milk	200 grams	7. Pineapple Juice	200 grams
Aminoids	20 grams	Aminoids	10 grams
Food Value:		Food Value:	
C-17 P-15.6 F-8.2 Cal.204		C-29.1 P-5.1 F-0.7 Cal.-143	
2. Skim Milk	200 grams	8. Pear Nectar	190 grams
Aminoids	15 grams	Lemon Juice	15 grams
Food Value:		Aminoids	10 grams
C-15.3 P-14.2 F-0.6 Cal.123		Water - 200 cc	
3. Milk, whole	180 grams	Food Value:	
Egg	1 each	C-16.0 P-4.5 F-0.11 Cal.-84	
Sugar	10 grams	9. Lemon Juice, clear	25 grams
Aminoids	15 grams	Sugar	10 grams
Food Value:		Aminoids	10 grams
C-24.3 P-19.4 F-12.6 Cal.-287		Water - 200 cc	
4. Custard: baked		Food Value:	
Egg	1 each	C-16.0 P-4.5 F-0.1 Cal.-84	
Whole milk	120 grams	10. Tomato juice	200 grams
Sugar	10 grams	Lemon juice	10 grams
Aminoids	10 grams	Aminoids	10 grams
Food Value:		Food Value:	
C-19.5 F-15.2 F-10.1 Cal-231		C-11.7 P6.5 F-0.3 Cal-75	
5. Baked Custard		11. Cooked Oatmeal	150 grams
Same as IV, but substitute skim milk for whole		Aminoids	10 grams
Food Value:		(Should be served with cream or milk and sugar)	
C-19.5 P-15.6 F-5.5 Cal.-190		Food Value:	
6. Grape juice	200 grams	C-15.5 P-7.5 F-1.5 Cal-106	
Aminoids	10 grams	12. Hot clear broth	200 cc
Food Value:		Aminoids	10 grams
C-33.7 P-5.1 F-0.1 Cal-156		Food Value:	
		C-4.1 P-9.7 F-0.3 Cal.60	



## III.

CASEC FORMULA (x)

Milk	-	250 gms.		
Eggs	-	2		
Casec	-	20 gms.	Total Protein	- 44 gms.
Ice			Calories	- 563
Cream	-	80 gms.		
Cocoa	-	5 gms.		

## IV.

HIGH PROTEIN, TOMATO SOUP (xx)

	CHO	Pro.	Fat	Thiamin	Riboflavin	Niacin
		Grams			Milligrams	
Butter 35 gm.....	-	-	28	-	-	-
Casein 15 gm.....	-	13	-	-	-	-
Wheat germ (Viobin) 15 gm....	7	66	-	0.495	0.120	1.035
Soy Flour 10 gm.....	5	5	2	0.055	0.040	0.400
Milk 240 gm.....	12	8	10	0.120	0.500	0.700
Bouillion $\frac{1}{4}$ cube.....	-	-	-	-	-	-
Tomato puree 2 tbsp.....	3	2	-	-	-	-
Salt to flavor (omit in patients with edema or ascites).....	*					
	27	84	40	0.670	0.660	2.135

Total Calories - 612. Total Protein - 54 grams. Will yield one bowl of soup.

In making the soup-

Melt butter in the top of the double boiler. Stir in the casein, wheat germ, and soy-flour. Mix in the tomato puree and bouillion cube (for variety other flavorings may be used.) Add milk gradually. Cook for 10 minutes.

If 2 cups a day are given at approximately 0900 and 1500 a total of 68 gm of protein will be furnished. A third feeding could be given at 2100.

## V.

TUBE FEEDING FORMULA (xx)

Total volume about 1500 cc. should be made up fresh daily, and kept in a closed container in refrigerator. Mixing in good mechanical mixer is necessary in preparation. Give feedings of approximately 100 ml., conveniently spaced throughout the day and/or night. Material is most readily given with a 50 or 100 cc syringe through a small nasal tube which may be left down for three weeks to four weeks. Use alternate nostrils at weekly intervals. The mixture may be given just as it comes from the refrigerator -- it is not necessary to warm it.

	Calor ies	Pro- tein	Ca	Fe	Vit. A	Thia mine	Ascor bic Acid	Ribo flavin	NA
		gm.	gm.	mg.	I.U.	mg.	mg.	mg.	mg.
Milk - 1 pt.....	350	16.8	0.56	1.0	8.6	30.19	5	0.86	0.53
Cream- 1 pt.18%.to.20%....	998-	14.0	0.43	1.0	5760	0.14	-	0.62	-
Raw liver*(freed of tendons) 4 oz or 120 grams.....	158	25.0	0.01	9.3	35000	0.38	37	3.00	17.00
Raw eggs - 4.....	316	25.6	0.11	5.4	1980	0.28	-	0.74	0.12
Dried yeast** 2 tbsp or 20gms	72	10.0	0.02	4.0	-	3.20	-	0.80	8.00
Glucose or Lactose or Sucrose or Karo Syrup, 225 gm or 7 $\frac{1}{2}$ oz	900	-	-	-	-	-	-	-	-
Whole milk powder-4tbsp or 22 gms.	109	5.6	0.21	0.4	310	0.07	1	0.35	0.15
Casein-4 tbsp or 30 gm.....	120	25.0	-	-	-	-	-	-	-
Applesauce, Apple Powder, or Pectin (4 tbsp, or 60gm. applesause.....	49	0.1	-	0.1	30	-	-	-	0.02
Salt - 10 g .....									
TOTALS FOR ABOVE.....	3052	119.1	1.33	21.7	41896	4.26	43	6.37	25.82

Orange juice - 4 oz or 120 cc.

(Give half with one of A.M.

feedings and half in P.M.....	59	1.1	0.05	0.4	300	0.09	54	0.03	0.26
COMPLETE TOTALS:	3111	12072	1.55	22.1	142196	4.35	97	8.40	26.09

Salt Concentration about 12 g.

- \* Ground beef or pork may be alternated with liver
- \*\* If considerable distention or diarrhea develops, substitute with equal amount of wheat or corn germ.
- \*\*\* This ingredient is added to prevent diarrhea and must be adjusted to the individual

(x) Courtesy Gardiner General Hospital, Chicago, Illinois

(xx) Stare, F.J. and Thorn, G.W., J.A.M.A. 127, 1120 (1945)

Amigen - Enzymatic casein hydrolysate: Mead Johnson Company, Evansville, Ind  
Manufactured for intravenous use as a 5% amigen, 5% dextrose solution, in liter flasks and for use as a soluble powder in one pound cans. Amigen powder is 75% protein.

Casec - Calcium caseinate, 88% protein. Mead Johnson Company, Evansville, Ind.

Aminoids - A mixture of wheat, beef, milk and yeast proteins, 45% protein, the Arlington Chemical Company, Yonkers, New York.

LT. COLONEL CONDUCT W. CUTLER: Forty-five of sixty-seven patients admitted to Cushing Hospital had bed-sores. Two of the sixty seven had slight progression of their bed-sores after admission. No case has developed a bed-sore following entry. The bed-sores are characteristically multiple, thus there have been 130 decubitus ulcers in the forty-five patients.

Important considerations in treatment have been found to be: Constant and repeated turning of the patient every two hours day and night. The use of small kapok pillows to prevent local pressure on sensitive areas. (Supporting the chest and pelvis on pillows in a prone position makes for comfort and better breathing.) Keeping patients dry at all times. Adequate nutrition and attention to avitaminosis and protein deficiencies.

In local treatment various applications have been tried, including vaseline gauze, penicillin jelly, granulated sugar, and a preparation of concentrated red cells with penicillin and agar. Of these the granulated sugar has proved particularly effective in diminishing pyocyanous infection and slough. Epithelization seems to be rather more rapid under this treatment. Cleansing of the wound and rapid development of granulations of a healthy character has followed the use of a paste composed of concentrated red blood cells thickened with agar and containing penicillin.

Associated with this type of preparation secondary closure has been used in seventeen cases and has proved most satisfactory in deep penetrating bed sores measuring not more than seven centimeters in diameter over the sacrum and five centimeters in diameter over the trochanter. In performing this closure, penicillin is given forty-eight hours pre-operatively and twenty-one days postoperatively. The wound is cleansed with saline, the edge of the decubitus trimmed away with complete undermining of the entire skin and sub-cutaneous tissue over the sacrum and low back out to the flanks for a distance of eight to ten inches, superficial to the gluteus muscle. Closure of the circular defect is performed with tantalum .010 suture in two layers, one for the deep fascia and one for the skin. No drain is employed. The wound is filled with penicillin solution and the same solution is injected through the suture line into the wound area twice a day for ten days. Stitches are left in place for twenty-one days. In trochanter decubitus the treatment is the same. Three layers are usually required in the suture, as the sore frequently extends through the fascia lata and the gluteus maximum fascia. These are closed separately from the sub-cutaneous and skin layers. A plastic extension is always necessary. Where complete suture closure has been effected, there has been no case of reopening or breaking down. Slower healing occurred in those cases which could not be completely closed.

1st LIEUTENANT MARK A. JACOBS: We have been most grateful to Captain Harper



for his valuable advice and helpfulness in suggesting diets for our patients here, but from our work it appears that diet is only a partial answer to the problem. Protein studies have shown the impoverished nutritional state of many of these men who have just returned from overseas. The fact that we have no opportunity of observing these patients until they have spent some time in the hospital overseas does not permit us to appraise their actual status in the real acute phase of their pathological condition. But as they pass into the sub-acute or chronic phase, it is apparent that there are many factors involved. Diet, lack of appetite, infections and even their mode of transportation to this hospital have an effect upon the patient's nitrogenous state. Those that travel by air seem to be in much the better shape.

Most of these patients have come to us in a poor state of nitrogen balance, and in mild acidosis. They have a hypoproteinemia with a reversal of the normal albumen-globulin ratio, and further laboratory studies showed many other things of importance. There were avitaminoses, calcium metabolic changes with the formation of renal and cystic calculi, infected kidneys and bladders, and varying sizes of necrotic skin ulcers. The kidney and bladder stones were found to be almost entirely of the alkaline type, including calcium carbonate, calcium phosphates and triple phosphates.

On arrival here we found that the skin ulcers that these patients had were a large possible source of their inanition and nitrogen imbalance. These decubitus ulcers varied in size and number but in all cases were infected and oozing. The material that oozed from these sores appeared to us to be such an important factor in the nitrogen balance, that we attempted studies on them to show the actual loss from this source. Little previous work had been done on this importance subject, and the results obtained were startling in some cases.

Through the use of cellucotton dressings of these ulcers we were able to obtain sufficient material for our experiments. By covering these ulcers with the pads for twenty-four hours, then doing a micro-Ejeldahl determination on the material contained on the pads, we found that these ulcers did have an important bearing on the nitrogen balance, hypoproteinemia and albumen-globulin ratio.

In fact, one patient with five ulcers of varying sizes and shapes was found to have a total protein loss from just these of over 40 grams in twenty-four hours. Others showed less in protein loss, but most proved to be important in nitrogen waste. Thus you can readily see the tremendous increase in protein intake that is necessary to even attempt to obtain a zero balance, much less achieve a positive one, since to this ulcer loss must be added nitrogen loss through the usual sources, such as urine, feces and perspiration. Also add to this the anorexia and the indifference to food itself and you can see how our problem becomes increasingly difficult of solution.

As infection from all sources was brought under control, the nitrogen balance gradually tended toward zero and the albumen-globulin ratio showed improvements, but maintenance of infection control was almost impossible. However, we believe that a partial solution to the problem was found in the use of skin graft coverings for the decubitus ulcers. Where and when this was done, the protein loss through these ulcers became negative, the patient tends toward and approaches a positive balance and the albumen-globulin ratio tends toward normalcy. We have no data yet on its permanency as far as maintaining such a balance is concerned.

We are attempting to clear up all sources of infection so as to eliminate any stimulus that might still exist. But there still remains the question of how to get enough proteins, enough calories and enough vitamins into these patients that do not want food. There is still a good deal of work to be done before definite conclusions can be reached, but we are increasing our store of data and material.

The question is still posed: How can we get these patients into positive nitrogen balance and maintain them thus by diet, with the difficulties and complications that face us at present?

CAPTAIN HAROLD A. HARPER: The study conducted here at Newton D. Baker Hospital on the losses of nitrogen in exudates is a valuable source of evidence to support our ideas on the greatly enhanced nutritional requirements of the

diseased state. Prevention of losses by this route make it much easier to control the high degree of negative nitrogen balance which otherwise exists. But in any case one must often take heroic measures to increase protein intake in order to reduce the amount of negative balance. Anorexia must be regarded not as inevitable but as a challenge. The objective in my presentation has been to outline workable methods to reduce if not entirely compensate for these nutritional inadequacies. These methods have been found entirely satisfactory in practice but they require constant individual supervision of the nutritional management of each case. It is therefore felt that we do have adequate means to control the nutritional aspects of this problem and it is hoped that they will find much more general application.

LT. COLONEL FRANK MAYFIELD: I wish to commend both essayist for excellent presentations on important phases in the care of the paralyzed patient. The healing of decubiti greatly promotes nutrition and adequate nutrition is necessary for the prevention and cure of ulcer. I am sure that all of us have gained many valuable points from these two papers.

Before I close this session I would like to express again my thanks to Colonel Beck for his invitation and Colonel Cook and Colonel Poer and his Staff, Major Elkins and all the Staff at Newton D. Baker for the program that has been arranged and for the cordial hospitality that has been extended us.



## PROCEEDINGS OF THE CONFERENCE

11 May 1945

### Evening Session

COLONEL E. A. NOYES (Presiding): Tonight we have run into the program something a little foreign to the main subject of the meeting, but personally, I feel it is just as vital as the treatment of cord cases, and I say to the visiting officers that we are just as proud of it as we are of our cord cases. It concerns treatment of osteomyelitis by dermatome grafts.

There will be three papers with discussions after all three papers have been presented. The first paper will be presented by Major Robert Kelly of Ashford General Hospital on "Dermatome Grafts for Chronic Osteomyelitis".

Following these papers and the discussion there will be a movie on the paraplegic patient.

MAJOR ROBERT KELLY: Colonel Noyes, distinguished guests and members of the staff of Baker General Hospital, the treatment of osteomyelitis by skin grafting procedures following saucerization is not new. It was described (Slide) by Neuber in 1895, some twenty years before publication of Orr's monograph (Slide). A few years later, in 1902, J. P. Lord, then professor of surgery at Creighton University, reported (Slide) with this illustration the result of treatment of a case of osteomyelitis of some fifty years' standing by saucerization and Thiersch grafting. Reid, in 1922, published a report in the Johns Hopkins Hospital Bulletin on the healing of chronic osteomyelitis by Reverdin grafts. Doubtless, he used this type of graft under the influence of Doctors Halsted and Davis. (Slide) Here is shown an illustration of one of his cases so treated. (Slide) Here we have another, two weeks after application of Reverdin grafts. (Slide) This is one of 46 years' duration, (Slide) and here, the result following saucerization and Reverdin grafting. (Slide) Here is shown another, three weeks after Reverdin grafting, and (Slide) this represents an osteomyelitic process just above the ankle extending through-and-through the tibia, after saucerization and Reverdin grafting. This case was of 30 years' duration. Why such reports did not lead to widespread adoption of the procedure is not clear. Armstrong & Jarman, in England, and Quick, in Australia, have employed this form of treatment, the latter for over 20 years. More recently, Converse has included osteomyelitis among war wounds of extremities for which he advocates early skin grafting. Lord again, and Beekman have advocated other forms of plastic procedures for the healing of chronic osteomyelitis.

In January 1943, we began to treat osteomyelitis by this method at Ashford General Hospital. We were fearful of recurrence, of local extension of the infection, and of systemic complications. We have withheld formal report of this treatment until recently when, after treating more than 100 cases over a 2 year period, we have felt that appraisal of these factors from our experience could be made.

#### Technique

A saucerization is performed, which we have come to regard as analogous to debridement of a fresh wound. All devitalized tissue, including scar, is removed. The contour of the wound must approach but need not duplicate that of a saucer (Slide). As soon as we are satisfied the wound will permit of the proper application of pressure, we sacrifice no further good tissue. When a vascular ligament, or tendon denuded of its sheath is left exposed in the wound, it is excised and subsequent reconstruction planned. Major arteries and nerves, of course, are preserved. The surface of the wound is then covered with a single layer of plain fine mesh gauze, made as wrinkle-free as possible. (Slide) Mechanics' waste packing is applied over this and packed in carefully to produce firm pressure as uniform as possible to all areas of the wound.

Over this, when available, is wrapped an ace bandage. Lacking this, some other form of pressure bandaging is employed. The firmer the pressure which can be made without embarrassing circulation, the better the result. It is technically difficult by circular wrappings of any form of pressure agent to maintain uniform pressure extending to the base of the digits of the extremity. For this reason, in extremity work we have employed the pressure agent locally and often made the plaster immobilization unpadded distal to the pressure agent. The plaster is then split from top to bottom through its entire thickness. Little difficulty has been encountered from swelling, none from decubitus. Our interval between saucerization and grafting while our earlier cases were being done varied from zero to more than thirty days. Now it is usually in the range of four days.

For skin grafting, as large a donor area as possible is prepared, and the plaster is bivalved. In the operating room the bivalved plaster is removed and the packing withdrawn from the wound. Split thickness grafts are obtained with a dermatome and fitted accurately to the surface of the wound. It is imperative that the graft fall of its own weight into the most remote recesses of the wound, and that it be free of wrinkles. Along the lines of suture necessitated by trimming the graft for fit, untied running sutures may be placed, to be withdrawn following "take" of the graft. The graft is sutured to the adjoining skin edges and a pressure dressing applied similar to that previously described, sometimes omitting the layer of fine mesh gauze. Dakin's tubes may be incorporated in the mechanics' waste of these pressure dressings after both saucerization and skin grafting, and through them local chemotherapeutic agents instilled. An ace bandage is more imperative at this stage in that swelling is permitted with less increase in pressure. The pressure now made in the initial wrapping of the ace bandage is less than that made following saucerization, being the same as for any other skin graft. Over the pressure agent a fairly thick layer of sheet wadding is built up so that expansion of the pressure dressing will not be limited by the walls of the plaster. Again the plaster may be made unpadded distal to the pressure dressing and handled as before.

The smaller the amount of drainage, and the cleaner the odor, the longer the dressing is allowed to remain. Many of our dressings are removed after four days, and practically all after six days. Following removal of the dressing, appropriate immobilization is maintained. The wound is left exposed as much as possible, still providing for protection from mechanical irritants. It is kept moist with boric or acetic acids in weak solution, or with penicillin, depending upon the culture report. The greater the amount of necrotic material present, the greater the necessity for moisture by these agents. Local penicillin has seemed disappointing in its effectiveness, perhaps because *B. proteus* and *B. pyocyaneus* may have been present when it was used, though not revealed in routine cultures. Healing from this point has not been rapid. Of course, we do not consider healing complete until the entire area is covered by epithelium, and no drainage, exudate, seepage, or other type of moisture emits from the wound. By the end of two months, healing is usually complete. Commonly there is a high percentage of apparent "take" followed by a period during which maceration results in considerable apparent loss of graft. Many interesting things have happened during the period following removal of initial skin grafting dressings. On several occasions results which appeared worthless at first dressing have proved highly gratifying within three weeks. Detailed enumeration of these interesting occurrences would be of no value at this time.

### Results

The x-ray criteria on which a diagnosis of active osteomyelitis may be based are unsatisfactory. We have considered osteomyelitis to exist where a granulating wound is found in continuity with a process presenting by x-ray, evidence of bone damage with one or more of the following: (1) Necrotic fragments. (2) Periosteal reaction. (3) Hazziness of trabecular detail. (4) Evidence of localized decalcification. Six months ago a group of cases was selected purely on the basis of most strikingly meeting these criteria. Forty-five osteomyelitic processes were present in 43 patients on whom 47 skin grafts were performed. We evaluated our results (Slide) on these criteria. The results were:



Excellent 24%  
Good 28%  
Fair 24%  
Poor 24%

Several of the cases evaluated as poor at that time have since proved quite satisfactory.

COLONEL NOYES: The next paper, "Obliteration of the Defect in Bone in Cases of Osteomyelitis Closed by Dermatome Grafts", presented by Lt. Colonel Marvin P. Knight and Captain George O. Wood of Crile General Hospital.

LT. COLONEL M. P. KNIGHT: A major problem in the reconstructive surgery incident to war wounds is bone infection or osteomyelitis with resultant distortion of bone contours and loss of substance due to sequestration. Many new methods of therapy resulting in shortened periods of disability are being constantly introduced (especially since widespread use of the newer chemotherapeutic aids) presumably because the current and accepted method of treatment of traumatic osteomyelitis by sequestrectomy and saucerization, chemotherapy, adequate drainage and prolonged plaster cast immobilization has well known disadvantages such as inconvenience to the patient, the total period of disability and the ultimate functional result. Surgeons dealing with these problems are aware of the fact that, with this method of treatment of osteomyelitis, bone cavities with or without non-union are very prone to occur.

These bone cavities with their rigid bounding walls are reluctant to heal and even though eventually healed by granulation tissue are not only subject to recurrences of inflammation and suppuration, but because of loss of bone substance, so weaken the bone that full use of the extremity may not be possible. Thus, the bone may be "united" but with grossly inadequate union for full utility and, therefore, subject to refracture at a later date unless carefully guarded. One is not infrequently confronted by a patient whose "bone is healed" but whose joint and muscle function is so impaired and the possibility of osteomyelitic recurrence so great that it is open to question whether the patient would not be benefited if the extremity were amputated and a prosthetic limb fitted.

We have developed procedures which, we feel, expedite healing and in many cases circumvent the complete development of these cavities with eburnated margins within the substance of the long bones of the extremities. During the past year we have performed in the neighborhood of 200 sequestrectomies and saucerizations in the course of this development of procedures which seem superior to the usual methods surgical management of infected, compound fractures. Many of these cases are now nearing the terminal phases of their reconstruction and the present preliminary report includes those cases on whom the entire series of reparative procedures have been performed.

These procedures consist of early and complete saucerization of the involved osteomyelitic bone, followed in from five to twenty-one days by the application of split-thickness grafts as "dressings" into the depths of the saucerized areas. This effectively converts the infected wounds into closed fractures so that the wounds remain healed and dry but, by this technique of radical saucerization and the application of split grafts, large lacunae and bone defects remain which seriously weaken the bone as a supportive structure. Bone does not regenerate beneath these adherent split grafts to any appreciable degree and the lacunae remain essentially the same in spite of a tendency toward contracture beneath the grafts which decreases the volume capacity of the saucerized area but does not represent an increase in the amount of bone present. The split-thickness graft is notoriously unstable when exposed to trauma, and in this respect, these grafts on bone are no exception even though they are depressed beneath the skin level and thus protected somewhat from trauma. Thus, in most instances, it has been found necessary to replace the split-grafts with full-thickness skin by some plastic method, both for epithelial stability and to permit further reconstructive surgery on the involved bone.

The large skin-line bone cavities resulting from these extensively saucerized wounds present quite a surgical problem relative to closure and

obliteration of the cavity with restoration of bone contour. In the past, attempts have been made to obliterate septic bone cavities by the introduction of antiseptic paste or waxes, fat grafts (either free or pedicled) and pedicle grafts of muscle into the unlined, infected cavities. Similarly, pedicles of skin and fat have been introduced into the cavities in an effort to secure an epithelial covering without any attempt at obliteration of the cavities. Success has been variable and uncertain, and little attempt has been made to increase the amount of bone present. In the present series, an attempt has been made to obliterate these clean, skin-lined cavities in such a way as to provide for increased osteogenesis in the region of the lacuna by bone graft and at the same time to supply a stable, epithelial covering by the immediate closure of adjacent skin margins or by the shift of pedicle flaps.

#### DETAILS OF THE STAGE PROCEDURES

##### The First Stage: The Saucerization and Preparation of the Osteomyelitic Cavity.

This important and necessary stage in the treatment of an osteomyelitic, compound fracture is planned and carried out with the thought in mind that the resultant wound should be adaptable to the early application of a split thickness skin graft dressing and that the final scars following reconstruction should be advantageously placed. All non-viable bone and bone of questionable viability should be removed and the fracture site well saucerized so that granulations will cover the bone surfaces in the shortest possible period. An attempt is made to preserve any union which may be present but occasionally minimal fibrous union may have to be sacrificed. For obvious reasons all cicatricial soft tissue in the region of the fracture is excised as completely as possible and in the event that a joint is involved in the osteomyelitic process, the cartilage is similarly removed. The wound is packed open in the conventional method with vaseline gauze, and the operated limb is provided with temporarily immobilization pending subsequent operative procedures.

After five to seven days the wound is inspected and its suitability for skin graft determined. Usually it is healthy with a very thin layer of granulation tissue overlying the bone surfaces, but occasionally in those cases in which suppuration has been allowed to continue over a sufficient length of time to produce extensive soft tissue fibrosis and bone sclerosis, the outward growth of granulations over the eburnated bone surfaces probably will be slow. In these cases grafting must be deferred until the bone is covered with the minute granulations necessary to a successful skin grafting. With the gradual accumulation of clinical experience and judgment, the saucerization stage can be so modified as to obviate this difficulty. Those cases in our series in which an unusual period of time has elapsed between stages may be explained by the length of time the osteomyelitis had persisted before this method of treatment was instituted, the degree of osteo-sclerosis about the fracture site at the time of primary operation and the lack of accumulated experience necessary to adequately determine the proper method of dealing with osteo-sclerotic bone in this type of plastic repair.

##### The Second Stage: The Split Thickness Skin Graft Dressing.

With the Padgett dermatome making the procurement of large split thickness grafts of predetermined thickness possible, little difficulty is experienced in obtaining enough graft material for covering the largest saucerized areas. This thin graft (.010-.016 inches in thickness) is obtained from the most convenient source, perforated, and its rubberized epithelial surface dusted with sulfathiazole powder. The recipient area is then prepared by curettement of the granulating surfaces with removal of any tissue which appears edematous or avascular. The graft is then applied to the saucerized areas and tailored to fit the depressed, irregular bone cavity by shaping the thin sheet of split skin into an irregular, blunt cone. The graft margins are sutured to the skin edges and pressure dressings of ordinary machinist waste are meticulously placed from the bottom of the cavity outward as all recesses must be completely and tightly filled to insure intimate contact between the parasitic graft and recipient area. The entire extremity is wrapped with an elastic bandage, temporarily immobilized, and chemo-therapy administered over a two to three day period. The initial dressings are routinely



removed at the end of six days and ordinary vaseline gauze dressings instituted. At this dressing it is usual to find that from 80 to 95% of the skin graft has "taken" and not infrequently one finds the entire surface completely epithelialized. Subsequently, the wounds are treated in much the same manner as any skin graft surface with proper attention to the underlying bone pathology. Immobilization is continued in accord with established principles with physiotherapy as indicated. Surface care of the new epithelium is administered daily through windows in the casts or bivalved casts, depending upon the degree of union of the fracture.

When the grafted surface is completely epithelialized and the desquamative process has diminished so that the graft is relatively stable, further surgery is indicated for the obliteration of the bone cavity.

The Third Stage: The Obliteration of the Bone Cavity with Autogenous Bone Chips.

The principal factors in the success of this stage are:

1. The planning of suitable epithelial covering for the lacuna.
2. The complete excision of a split thickness graft from the depth of the saucerized area.
3. The procurement of a sufficient amount of bone chips to fill the cavity.
4. The covering of the chip-filled cavity with the skin and subcutaneous tissue in such a manner that tension is avoided.

In planning the epithelial covering for the lacuna, it is frequently possible to undercut the margins of the skin adjacent to the cavity so that viable full thickness skin may be closed over the cavity without tension. It has been found advisable, when possible, to plan the closure so that the suture line does not overlies the cavity as it has been found that the incision apparently heals better when not "floating" over the recently filled cavity. Therefore, it is frequently necessary to elevate a double pedicle sliding flap in the region adjacent to the cavity and shift the flap to relocate the suture line. These flaps may usually be shifted without delay and their viability will usually be satisfactory if the ratio of length to width does not exceed 3 to 1. In most cases one flap is adequate but occasionally it is necessary to raise flaps on both sides of the cavity. Rarely, after the flaps are elevated their circulation may not seem adequate, so that it becomes necessary to "delay" the procedure by returning the flaps to their original bed and not proceed with the remaining operation until two or three weeks later. Occasionally when an extensive loss of surface covering has occurred, it may be necessary to migrate skin and subcutaneous tissue by the pedicle method from more distant sources.

With satisfactory full thickness epithelial covering of the lacuna assured, it is safe to proceed with the excision of the split thickness lining of the saucerized area. The marrow canals are then reopened and the bone surfaces scarified throughout. Autogenous bone chips are then procured from any convenient source in quantities sufficient to fill the cavity (the wing of the ilium has proven an excellent source). These chips are transferred to the prepared cavity and the flap or flaps over the filled lacuna. A split thickness graft obtained from the thigh is utilized to cover the denuded area representing the former location of the pedicle flap. Pressure dressings of machinist waste are again utilized. Post-operative chemotherapy is instituted over a period of three to five days with the inspection of suture line and flap covering of the lacuna on the third day. If any tendency toward accumulation of fluid is noted, it is aspirated and the region irrigated with penicillin through the aspirating needle.

As soon as the sutures are removed, the extremity is treated in the orthodox manner as indicated by routine orthopedic judgment.

## SLIDES

### LOZON-

- Fracture, compound, comminuted, complete, proximal third, left tibia, sustained 30 May 1944 as a result of high explosive shell fragments.
- Operative procedures:
1. 19 June 1944 - Secondary closure of wound medial aspect, left tibia, overseas.
  2. October 1944 - Sequestrectomy and saucerization, Crile General Hospital.
  3. November 1944 - Split thickness skin graft, lacuna, left tibia.
  4. Secondary closure of skin over defect in bone, in December.
  5. April 1945 - Application of bone chips.

### ROMANOWSKI-

- September 1944 - Incision and drainage, left leg.  
November 1944 - Sequestrectomy and saucerization, left tibia.  
November 1944 - Application of split thickness graft to saucerized area.  
March 1945 - Plastic obliteration of bone cavity, left tibia.

### DeGOOD-

- October 1944 - Sequestrectomy left tibia, proximal third.  
September 1944 - Split thickness skin graft.  
January 1945 - Shift of pedicle over lacuna with application of split thickness graft, lateral aspect of the knee.  
March 1945 - Bone graft, chip type from wing of ilium, left tibial cavity.

### ARMENI-

- 6 March 1944 - Split thickness graft applied overseas.  
8 November 1944 - Plastic repair of cicatrix, left tibia and osteoperiosteal graft from right tibia.

### SKIBA-

- October 1944 - Sequestrectomy and saucerization, left tibia.  
18 October 1944 - Split thickness graft to saucerized area.  
November 1944 - Plastic repair of bone cavity with bone chips from wing of ilium.

### WELLAR-

- December 1944 - Sequestrectomy and saucerization femur.  
January 1945 - Split thickness graft, saucerized area.  
April 1945 - Plastic obliteration of bone cavity with bone chips from ilium.

### HORNER-

- February 1945 - Sequestrectomy and saucerization.  
27 February 1945 - Split thickness graft to saucerized area, left femur.  
16 April 1945 - Plastic obliteration of bone cavity with chips from left ilium.

### DRUESCHEL-

- January 1945 - Sequestrectomy and saucerization.  
February 1945 - Application of split thickness graft.  
15 April 1945 - Obliteration of bone cavity with chips from wing of ilium, tibia.

### DELLI BOVI-

- January 1945 - Sequestrectomy and saucerization, right tibia.  
23 January 1945 - Split thickness graft, bony defect, right tibia.  
February 1945 - Removal of split thickness graft; obliteration of bone defect with bone chips from wing of the ilium.

## SUMMARY

A method has been presented for the obliteration of bone cavities by autogenous bone graft and plastic skin closure. Twelve cases are presented in whom these methods were clinically employed in the treatment



of traumatic osteomyelitis with cavitation. Since the first two cases were operated, the time intervening between saucerization and the application of the split thickness graft has been decreased to seven to ten days. The final procedure, that is filling in the cavity with bone chips following in three to eight weeks when epithelial covering is adequate. In the first three cases treated the skin flap was transferred over the bony defect leaving a large hole underneath the flap and it was necessary in two of these cases to carry out aspirations of the hematoma for several days post-operatively. From this experience it was observed that progress was more satisfactory when the bone cavity was filled with bone chips at the time the flap was shifted, rather than shift the skin and follow this with filling of the defect some two or three weeks later.

This seems to be a more reasonable method of dealing with this problem than methods previously employed in that not only is infection eliminated at an early date but also an attempt is made to promote osteogenesis by bone graft and a stable epithelial covering is provided by surgical methods.

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We express our gratitude to Mr. L. R. Johnson of Cleveland, Ohio, for his untiring effort in taking and producing the photographs.

COLONEL NOYES: Lt. Colonel Robert L. Preston, Orthopedic Consultant from the Fifth Service Command will discuss "Dermatome Grafts on a Production Basis in the Fifth Service Command".

LT. COLONEL R. L. PRESTON: Colonel Knight and Major Kelly have discussed their experiences with dermatome grafts for chronic osteomyelitis wounds. I would like to summarize the results we have had with this method in the Fifth Service Command and to mention some of the impressions I have received from the observation of this work in our hospitals. A year ago, after seeing the excellent results of Major Kelly, at the Ashford General Hospital, I passed the word around and began to urge that the method be tried in the other hospitals. At that time the Orr-Trueta treatment, with or without local penicillin or sulfa drugs, was the treatment of choice for most of the cases.

#### Disadvantages of the Orr-Trueta Technic.

It has long been recognized that there are many disadvantages to the Orr-Trueta treatment.

The prolonged immobilization results in considerable residual soft tissue disability. Considerable impairment of function of the extremities may result from the freezing of the joints, fascias and muscles during the period of immobilization.

During the long period these wounds are packed open a large amount of protein is lost in the wound discharges making it difficult to maintain the patients in nutritional balance.

Many of the wounds heal with dense scar which must be excised before function can be restored.

Areas of sclerosis and areas of soft tissue scar usually develop in the bone as it heals under the influence of the Orr-Trueta treatment.

When the patients treated by the Orr-Trueta technic are compared with those treated by adequate saucerization and the early application of dermatome grafts it is apparent, that in the cases treated by skin grafts, the texture of the bone usually has a more normal appearance on X-ray, there is less residual scar, the function of the extremity is better at the completion of the treatment and the patients remain in better general condition during the course of the treatment.

#### Secondary Closure.

The question arises as to whether these wounds can be closed by secondary suture of the skin over the saucerized bone defect so as to save

one step in the reparative process. The cases we are discussing this evening have had purulent discharge from infected bone cavities for four to five months so that conditions are not suitable for secondary closure. The situation is entirely different in the cases on which secondary closure has been used so successfully in the overseas hospitals; the cases in which the infection has not had a chance to become established. It has been demonstrated that a very high percentage of split thickness skin grafts will survive in the presence of infection. The secondary closure of these badly infected wounds is not compatible with accepted surgical principles and I do not believe that the percentage of good results can be expected to compare with those which follow the use of split thickness grafts. We have used secondary closure on an occasional, exceptionally favorable, case. I believe that we should continue to reserve this procedure for this type of case and use the dermatome graft for the routine cases.

Our principle objective is the elimination of the infection as soon as possible so that definitive plastic or bone surgery can be done. The wounds seem to remain closed once healing has taken place. Of course, in many of the cases, the dermatome grafts must be replaced after healing by more suitable full thickness grafts but it is my impression that this secondary procedure is not required as frequently in these cases as it is in those treated by the Orr-Trueta technic.

During the past year 550 cases have been done; most of them by Colonel Knight at Crile; Major Kelly at Ashford; Major Rizzo at Fletcher and Lt. Burgess at Billings, with a few cases in each of the other hospitals.

Slide 1 - Statistics

Number of Cases - - - - -	550
Cases which can be evaluated- - - - -	498
Interval Between Saucerization	
and Graft- - - - -	0-30 days
75% of Cases - - - - -	4-9 days
Completely healed	
in One Month - - - - -	52%
In Two Months- - - - -	89%
Failures (not healed in two months) - - - - -	11%

Saving of Hospitalization

In 89 per cent of the cases the wound has healed within about two months after saucerization. This is about two and a half months earlier than can be expected with the Orr-Trueta treatment, as the average healing time with that method is about four and a half months.

A considerable saving of hospitalization is effected by the use of the dermatome grafts.

In Conclusion:

After observing the results of this work, done by a great many surgeons in the Fifth Service Command during the past year, I believe that the technic is suitable for the production line methods which are necessary in a busy general hospital, that the end results are better than those with other methods, that hospitalization time is saved, and that the method is now well enough established to be adopted as the standard treatment for chronic osteomyelitis resulting from compound fractures.

COLONEL NOYES: We will now proceed with the discussion. We would like very much to hear from the Surgical Consultants from other Service Commands.

Papers as follows:

Dermatome grafts for Chronic Osteomyelitis presented by Major Robert Kelly, Ashford General Hospital.



Obliteration of the Defect in Bone in Cases of Osteomyelitis Closed  
by Dermatome Grafts presented by Major M. P. Knight, Crile  
General Hospital.

Dermatome Grafts on a Production Basis in the Fifth Service Command  
presented by Lt. Colonel Robert L. Preston, Fort Hayes.

COLONEL IDYS MIMS GAGE: I wish to congratulate Majors Kelly and Knight and Lt. Colonel Preston for this real contribution to the treatment of localized osteomyelitis of the osseous system. When Major Kelly stated that he saucerized the bone, I immediately thought of the saucerizations recommended years ago (first in Germany) for the treatment of chronic osteomyelitis. This saucerization was the removal of two-thirds of the circumference of the shaft of a long bone involved in an osteomyelitic process of a chronic nature. I was always against such an insult to an uncomplaining bone. (The osseous tissue is just as sensitive to trauma as the conjunctiva and should not be mistreated as though it was a concrete pipe.) I have never done a saucerization of a bone for chronic hematogenous osteomyelitis, and, God willing, I never will. The operation for chronic osteomyelitis (localized form) is not a true saucerization but is comparable to a localized debridement of the osseous tissue, and I think the word debridement should be used instead of saucerization.

The results shown here tonight in the cases of localized traumatic osteomyelitis are most noteworthy. The question of removal of all devitalized and infected bone with skin grafting within 9-10 days is based on sound surgical principles. Its superiority over the Orr treatment of these cases is unquestionable. The Orr treatment is one that is prolonged, costly and questionable. Review of the cases treated in Spain that migrated to France where they were evaluated, demonstrated the inadequacy of accomplishing bone healing and the elimination of infection.

The method advocated tonight produces rapid healing of both the osseous tissue and soft parts. The osseous tissue which showed sclerosis before debridement and grafting reveals a dramatic change, i.e., rapid decrease of sclerosis due to revascularization of the entire circumferential bone edge of the cloaca. The time of hospitalization has been shortened almost 50%.

The addition to the procedure as reported by Major Knight, the use of bone chips, and a sliding graft, accomplishes two things: heals the osteomyelitic process and restores bone continuity at the same time. This will overcome subsequent grafting and again shorten hospitalization and prevent chronic toxemia with all of its undesirable complications and sequelae.

Dickson of Kansas City in 1940 reported, I believe it was 13 cases of chronic osteomyelitis that he had debrided, applied sulfanilamide to the wound with skin closure with primary healing. This was quite a step forward in the treatment of these cases.

Therefore, we must give the sulfa drugs, and especially penicillin, credit for making it possible to treat the cases of osteomyelitis by the methods advocated by the essayist tonight.

I would like to congratulate all the surgeons of the Fifth Service Command, who have taken part in this contribution in the treatment of traumatic osteomyelitis. I consider it one of the real advances in surgery of the osseous system of World War II.

The only regret that I have tonight is that the surgeons and orthopedists of the Fourth Service Command are not here tonight to hear these contributions and to see the remarkable results that have been obtained in the treatment of osteomyelitis.

COLONEL NOYES: Thank you, Colonel Gage.

COLONEL W. B. PARSONS: Colonel Cook and Gentlemen: I would like to

indorse heartily Colonel Gage's congratulations on this splendid piece of work. I was glad to hear him speak about saucerization and agree with him that this is a bad word. Another word that I hate is the word packing. It is too bad we do not have better words to describe what we do when we dress a wound. I do wish someone would find a nice short word to describe the right way to place gauze into a wound. Perhaps the younger ones here do not have any misunderstanding, but I am sure that most of us older ones think of saucerization as being different from what was done in the cases reported. This was really sequestrectomy. There is a great difference between osteomyelitis of the hematogenous variety and the osteitis occurring in military compound fractures and there is also a great difference in the military cases between the problems presented by the shaft as compared with the end of the long bone. In the lower leg, if for some reason or other, a wound has not had secondary closure at an early date, it will be wide in relation to its length, or deep in relation to both width and length by the time it has arrived in one of the general hospitals in the states. Even so, such wounds involving the shaft of the humerus or femur can be satisfactorily closed by shifting soft tissues after removal of minimal amount of diseased bone. There is a nice series of such cases being done by Lt. Colonel Horwitz at Vaughn General Hospital. By covering the defect by plenty of soft parts one has produced the ideal conditions for a subsequent reconstructive procedure. Cavities in the upper end of the tibia and in the sacrum represent perhaps the two most difficult problems to solve. I think this method as reported here is a very sound one to hasten healing in the bone, that it will be particularly useful in the closing of cavities in cancellous bone and should be used whenever it is impossible to bring soft tissues together over the defect.

LT. COLONEL C. WL. CUTLER, JR: These cases at Cushing General Hospital have been managed by Captain Richard S. Dodge, under the supervision of Major Tobin of the Orthopedic Service. The following principles of treatment have obtained:

1. Maintenance of the most advantageous position of fracture fragments until bony union occurs or surgical fixation is indicated.
2. Elimination of active infection.
3. Fortification of the patient's natural defense mechanism.
4. Reduction to a minimum of a period of disability, consistent with maximum restoration of function.
5. Reduction of the incidence of recurrence of infection.

General systemic measures and supportive therapy are consistently pursued. Penicillin has been utilized systemically prior to any operation undertaken and for an indicated period following it. Complete and meticulous removal of necrotic tissue, both bone and soft tissues, have been carried out, at the appropriate time in each case.

Four groups of cases have been followed for the purpose of comparing different types of local treatment of the resulting wound.

Sixty cases were treated by the following method:

After sequestrectomy, gauze saturated with penicillin solution, 1500 units per cc. was placed in the wound. This was changed daily under operating room conditions of asepsis. Seventy-one per cent of these were closed in an average time of two weeks without further intervention. The sequestrectomies in this group were not of the wide excision type, but consisted of exploration and careful clearing out of the sinus tract and fracture site with removal of minimum healthy uninvolved tissue.

Twenty-two cases were treated, following sequestrectomy, by closure of the wound by suture with a rubber catheter inserted to the depths of the cavity. Local penicillin was instilled into this catheter at four-hour intervals for an average period of two weeks before the catheter was



withdrawn. Twelve or fifty-four per cent were healed in an average time of three and one-half weeks.

Fifteen cases have recently been treated on the saucerization program. At the time of sequestrectomy wide excision and saucerization of the wound was done, with subsequent skin grafting on the surface of the wound, about eight days later. This groups has been too recently undertaken to permit evaluation.

The general observations on these groups of cases have given the following impressions: Those cases treated by penicillin gauze and repeated dressings apparently clear up early. An optimum condition of the wound and a minimal amount of discharge is noted at approximately two or three weeks. From that period on, the progress of the wound is much slower and the general appearance less healthy. The method of incasing the part in plaster following elimination of culturable bacteria seems to involve a longer period of treatment, with no apparent benefit. Those cases in which closure with the injection of penicillin through a catheter was employed have tended to show the presence of an unobliterated continuing deadspace in the depths of the wound. Even though skin healing results, reopening of the wound has occurred in some instances. The technique of this procedure has not been well worked out and it may have possibilities which are not yet realized.

The saucerization method of treatment followed by skin grafting seems to be applicable in the wounds where the bone is superficial. Closure by flaps or secondary soft part suture is appropriate where the wound is deep. The cleaning up of the wound adequately to permit either of these procedures depends on complete sequestrectomy, systemic penicillin, meticulous aseptic technique in dressings and avoidance of too much interference. It has been found that the gross clinical aspect of the wound is a better guide to its condition and readiness for further surgery than are culture to determine the pathogens in the wound.

A development of considerable interest at this hospital has been the undertaking of oblitative osteotomies, and in some instances, even arthrodeses in the presence of open granulating wounds, as proposed by Dr. M. N. Smith-Peterson, civilian orthopedic consultant to S.G.O. This has been undertaken in a few cases, with, so far, satisfactory results and without untoward complications. In such wounds, penicillin has been used locally in the depths of the wound, introduced through the Smith-Peterson cannula and under the guidance of its originator. No conclusions or report are possible at this time because of the relatively small series of cases thus far treated.

COLONEL W. B. WISE: I don't want the 3rd Service Command to be left out of the congratulations that are due Colonel Beck, Colonel Preston, and others who have done such wonderful work in this Command and added such a contribution. The answer to these problems, I think, is going to be a combination of the things we have heard tonight. This war has brought out many new procedures and we go on step by step. This is certainly a great step but along with it we should take full advantage of some other things done under the protection of chemotherapy and penicillin. While mentioning penicillin, I should like to ask the essayists to give a little more detail about their methods of using this drug. One said that these cases were treated two or three days after operation. I wonder that treatment is not begun before operation to prevent reactivation of the osteomyelitis or other infections and continued for a rather good length of time after operation, in the light of knowledge as to how penicillin works. As to other measures to be used in reparative surgery of soft parts and bone, I would like to stress particularly the pressure dressing. The differences between the results of inadequately applied pressure dressings and those carefully applied are very striking. We see in plastic surgery great liberties being taken about the face, eyes, nose, mouth, and other parts that cannot readily be sterilized. Careful application of pressure dressings seems to be a sort of magic that has beneficial effects in prevention of infection. A combination of all available measures should give a comprehensive program from which to select, using secondary closure in certain instances as recommended by Churchill, not, of course, in the expanded part of the tibia but perhaps in the femur and



other deep lying bones that are better adapted to this procedure, using thin or dermatome grafts in the types of cases that we have been so well exhibited tonight. There will, no doubt, be areas where sliding grafts cannot be done and pedicle grafts will have to be used.

I, likewise, would certainly have had some of our orthopedic surgeons here if I had known in advance that such outstanding orthopedic advances were to be presented on the program. We have no Orthopedic Consultant in our Service Command, and I am anxious for our orthopedists to attend such meetings as this. After I saw the program it was little too late to get orders, but if permitted, I will send some of our orthopedists around to visit you.

COLONEL NOYES: I see Colonel Peterson here -

COLONEL L. T. PETERSON: I would like to add a word of emphasis to what has already been said. The work shown here tonight is a real contribution and is comparable to the reparative surgery being done overseas which we have all heard about. I visited a number of convalescent hospitals recently and had an opportunity to see cases with scars that were breaking down. We should practice excision of scars and application of skin grafts even more freely than is now being done. Major Kelly has made a real name for himself at Ashford in this type of work. Colonel Knight has shown us a solution to what has appeared to be an unsolved condition, that is, large defects in the upper end of the tibia. It appears that he has actually answered some of the questions which Colonel Cutler has raised. Where the knee joint is intact, it should be preserved and certainly it is better to fill the defect and maintain length rather than to shorten the tibia if the former can be done. This preserves the knee, although the shell might be thin. The procedure which Colonel Knight has done, filling defects with bone and covering with full skin, is preferable to any collapsing type of procedure. Where the knee joint is destroyed by trauma and infection there is little choice and arthrodesis is indicated. Colonel Noyes, I think your Service Command has made a distinct contribution in the work discussed here tonight. We have seen a certain reluctance on the part of the orthopedic surgeons to do early sequestrectomies and proceed as boldly as Colonel Knight and Major Kelly have done in actually covering defects with skin. I wish that all Chiefs of Orthopedic Sections and Plastic Sections could see this work, and I hope the consultants who are here will carry this message to other hospitals. It is a special pleasure for me to be here tonight to make a comment because I initiated Colonel Knight and Major Kelly into the service and want to personally congratulate them on their papers and also to congratulate Crile and Ashford General Hospitals on having them on the staff.

LT. COLONEL W. H. MCGAW: I would like to ask Major Kelly and Colonel Knight some questions on their excellent papers. First, I wish to state that my interest in free skin grafting to bone infections and cavities began in Melbourne, Australia. There I had the privilege of seeing some of Balcombe Quick's cases. One case particularly impressive had severe osteomyelitis of the os calcis. A large, irregular, through and through cavity had been successfully healed by free skin grafting, maintaining full tendo-achilles function. Mr. Quick accomplished this by using two dental wax molds introduced into the defect from both sides of the os calcis. He used one little trick for introducing and maintaining the graft in place. The Tiersch grafts were fixed on the molds by frosting them in place with ethyl chloride spray.

On returning home I had the luck to see Major Kelly's work at Ashford General Hospital. By careful work he has been shortening the convalescence and hastening complete healing. I find he is a very modest man. He hasn't mentioned the definite improvement as shown by serial x-rays of the bone itself after his method of skin grafting. It was apparent to me that the sclerotic bone around a cavity gradually changed its dense character to more normal looking texture and bony trabeculation. Likewise the cavities gradually became filled in and definitely smaller. I wish to ask him about his experiments on keeping excess skin in the refrigerator to fill in possible small areas lost at the initial grafting.

Colonel Knight has made valuable contribution to the treatment of



these difficult cases with marked bone loss. It was not clear to me when he advocated introducing the bone chips under the skin flap. Was this done at the time the flap was shifted or after it had completely healed in its new location? I also wish to ask if any of the bone chips sequestered later and if they did, were they all lost?

COLONEL NOYES: Major Antopol.

MAJOR WILLIAM ANTOPOL: I just happened to be on the side lines watching these amazing results. The laboratory at the Billings General Hospital was asked to make a bacteriologic survey of their cases of chronic osteomyelitis on the day before application of the split thickness graft, usually the seventh post-saucerization day. A method was applied by which the number and type of organisms on a unit surface could be determined. 210 cases were treated by this method on the orthopedic section of Billings General Hospital, of which 150 consecutive cases were taken after the bacteriologic method was standardized, (Table 1); 67 healed in 25 days or less, and 69 were successful between 25 to 50 days. In the former group there were 10 cases which had over 400 organisms per square centimeter, of which more than 20% were staphylococci; in the latter group 14. Only 14 of these 150 cases, or less than 10%, were failures. Of these failures, 7 or 50% had staphylococci in the same order of magnitude as the successful takes. Applying the chi square formula, these figures are of great significance; from this it might be concluded that if more than 400 organisms are present over a square centimeter of the wound, of which more than 20% are staphylococci, there is at least a 1 to 5 chances that skin graft will not be successful. It was also found that the presence of great numbers of other organisms, even more than 100,000, have no effect on the success or failure of the skin graft if staphylococci are not present in significant numbers.

TABLE 1.

Bacteriologic Surgery of 150 Cases of Chronic Osteomyelitis  
Treated by Saucerization and Split Thickness Skin Graft.

	NO. CASES.--STAPHYLOCOCCI*.	
SUCCESSFUL		
25 DAYS	67	10
SUCCESSFUL		
50 DAYS	69	14
FAILURE	14	7

\*Over 400 Organisms /CM.<sup>2</sup> of which more than 20% were Staphylococci.

COLONEL NOYES: In closing, I would like to ask the speakers to answer the questions that were put to them. Major Kelly, if you will.

MAJOR ROBERT KELLY: I would like to thank the discussors for their remarks. I would like to point out the fact that although the operation may not be a saucerization, more tissue is removed than in a sequestrectomy. The chemotherapy is usually started one day in advance of surgery and continued for several days.

We have used "icebox" skin in two cases. The third one is being done during the few days of this meeting. There has been, I would say, about fifty per cent take of skin on the wounds. We have allowed the skin to freeze, and that should not be done. The icebox skin probably has helped.

I would like to add one thought in regard to secondary closure and skin grafting of wounds. Might it not be true that when we have a wound



which cannot be secondarily closed without tension or dead space, or both, that then is the time we should apply a skin graft, the initial surgery being the same in either case?

LT. COLONEL M. P. KNIGHT: I think the first question asked me concerned abscesses following closures of full thickness skin over these bone defects before the application of chips. As I tried to bring out, the first two cases were treated by skin flaps from the lateral aspect of the skin-lined cavity, the chips not being inserted at that time. We found it was necessary to aspirate these lacunae. In a desperate effort to prevent this, it was decided to fill in this defect with bone chips from the wing of the ilium three weeks following the transfer of full thickness skin over the hole. In the second case treated in this manner, also before any had been filled in with chips, it was necessary to aspirate this defect many times, each of these cavities being clean and well covered with skin. Each aspiration was carried out somewhat like one would aspirate a tuberculous abscess, filling in the lacuna or hole by installation of penicillin following the aspiration. The second case finally healed enough so that it was not necessary to aspirate the lacuna, but X-rays three months later showed no reproduction of bone, although the skin had been well healed for four months without reaction to skin or bone. This soldier had been on a furlough 30 days, the lacuna being at the upper end of the tibia. During the procedure to fill in bone chips, there was found a small abscess which resembled the Brodie's abscess which usually has a sterile culture. This area was completely saucerized, filled in with bone chips and closed, and has remained closed since this procedure. This is the only abscess which we encountered during these cases either early or late. Since the filling in of bone chips in this particular case, there have been no ill effects. We have in the severe cases of osteomyelitis used a definite routine, using penicillin and sulfathiazole nine days previous to sequestrectomy and saucerization these patients were given 100,000 units of penicillin daily. The use of penicillin and sulfathiazole definitely has its effect. From another aspect it has definitely given us courage to do more radical procedures and this is especially true previous to the application of a split thickness skin graft over these large saucerized areas. However, we have in several instances not used penicillin or sulfathiazole and carried out the same routine, that is sequestrectomy and saucerization followed by the application of a split thickness skin graft dressing seven to ten days later without ill effects. We have also encountered some individuals who have been given penicillin four or five days post-operatively that have had severe urticaria and some slight elevation of temperature. We noted that when the penicillin was discontinued each cleared up from a few hours to a few days. As Colonel Gage mentioned, the treatment of osteomyelitic cavities with sulfanilamide in 1940 by Dr. Dickson of Kansas City, closure of skin over these defects preceded the closure by complete excision of scar in that area and especially in hematogenous osteomyelitis in children. I have noted also in these osteomyelitic bones from war time injuries, it is definitely indicated to excise enough scar tissue to good bleeding surfaces, but split thickness skin grafts take or heal in inverse proportion to the scar tissue remaining. When Dr. Dickson's article first appeared I used his method in closing some small sinuses which were definitely draining and it appeared to me at that time that the most essential thing was thorough saucerization and thorough excision of scar as much if not more so than the sulfanilamide itself. In the series of 18 skin flaps, 12 of which were shown here, we have found it far better following excision of split thickness grafts, unless it was definitely contra-indicated which we encountered in only one case that was not thoroughly saucerized, to fill in the defect with bone chips and to cover the area and chips with a full thickness skin graft in one procedure rather than removing the split thickness skin graft dressing, transferring the flap to cover the defect, leaving that flap floating as we did in the first two or three cases. In other words, in four to eight weeks following the application of this split thickness skin graft dressing, it is better to have one final procedure than to divide it up into two procedures. The hole is then filled in with bone rather than hematoma or serum - in other words, eliminating dead space.

Another question asked was as to the failure of these grafts. Thus far, I cannot say we have had a failure. One patient, the first one in which this procedure was carried out, has completely healed. The femur



is solid and he was transferred to a Convalescent Center. There has been in two cases superficial ooze of serum in one area of the skin flap but no infection in the region of the bone chips. I do not think we have had time enough following the first group of procedures to estimate or definitely say whether we have had a failure or not, but we have been enthusiastic concerning the first group of cases which have been treated in this manner. I can safely say we have saved joints in at least 50% of these patients by this method of treatment which, if they had been treated in the Orr treatment of osteomyelitis, would definitely heal with painful or arthrodesed joints. This method of treatment is definitely useful in the treatment of osteomyelitis near joints.

COLONEL E. A. NOYES: I want to thank the discussors for their remarks. It is gratifying to have the work discussed and accepted in this way. We will call on Colonel Beck to wind up the evening session.

COLONEL C. S. BECK: I am gratified to hear the remarks made by the surgical consultants. All these surgeons are close personal friends of mine and their remarks mean a great deal to me.

I should like to congratulate Major Kelly for starting this work in the 5th Service Command. I also want to congratulate Colonel Preston for instituting this procedure in the other hospitals. While this procedure is not original, it does seem to me that we have put this procedure on a production line in all the general hospitals of the 5th Service Command. At the present time, the operation is being done in large numbers in each of our general hospitals. Some of the general hospitals have one or two wards of dermatome grafts in patients with osteomyelitis. A great deal will be said in the future about this method of treating osteomyelitis. It certainly seems to me that this method has many advantages over the Orr method. The method provides a skin cover to the wound and the skin cover keeps bacteria and dirt out of the body and keeps hemoglobin and blood plasma in the body; it prevents the leakage of protein from the wound; the patient's nutritional condition improves, inflammation in the soft part subsides and as this occurs, tenderness leaves the wound. The soft tissues become pliable again, whereas, with an open wound these tissues become frozen together. The patient is very much more comfortable with the wound covered with skin. These surgeons who have done this work have gotten a great kick out of it. A plastic surgeon is not required to place the dermatome grafts, any good surgeon can do this. Saucerization of the bone sometimes requires judgment and skill, especially if the lesion is close to a joint. I think I have seen lesions so close to a knee joint that one would expect the osteomyelitic process to enter the joint. This method might prevent extension in the joint and thereby preserve a joint.

Further plastic work will be necessary in some of these patients. Later on the dermatome grafts may have to be replaced by a pedicle graft. We have been making these pedicles in each of our general hospitals and we have not been transferring these patients to plastic centers for such operations. I have discussed this matter with General Rankin and Colonel Carter and it is their opinion that a general surgeon can go ahead and do these pedicle grafts.

COLONEL E. A. NOYES: There will be a five minute break and then Colonel Cook has a movie taken at this hospital that he would like to show you.

# PROCEEDINGS OF THE CONFERENCE

Saturday, 12 May 1945

## Final Session

Major George C. Prather, Ashford General Hospital, Presiding.--The Symposium on The Paralyzed Patient will be continued with a discussion on "Ambulation and Support" by Captain James E. Cameron.

Captain J. E. Cameron:-- Ambulation or locomotion is generally conceived to mean the ability to stand and walk unaided. In the treatment of paraplegia we must modify this definition and consider that we start with the patient unable to voluntarily move a muscle below the spinal cord level of D-10, we feel justified in defining ambulation as the ability to get about by means of braces and crutches proficiently enough to care for oneself at home; to carry out the necessities of ordinary life without constant help from another person. We should, perhaps, call such a patient mobile rather than ambulant.

We feel that the following expected results justify the initiation of an early and vigorous program of ambulation in each patient with a spinal cord injury:

1. The morale factor. Patients with spinal cord injuries and paraplegia have an extremely low morale which influences their appetite and general health adversely. This is, of course, derived from the prospect of being unable to walk; any advance in their ability to get about either in a wheel chair or on crutches causes an immediate improvement in their general outlook on life, their appetite and general health.
2. Therapeutic exercise. In our 70 cases, 49 are incomplete or recovering, as manifested by gradual downward progression of the sensory level and return of function in previously paralyzed muscles. In many cases the prognosis cannot be given, even after direct inspection of the lesion at the time of laminectomy and it may be many months before any recovery takes place. It is in this group of cases (which in our series represents 70%) that the very early initiation of a program of ambulation is of immeasurable benefit. This benefit is derived from the passive exercise obtained in the swinging movements of otherwise paralyzed lower extremities. No amount of artificial or assistive physical therapy can make up the equivalent of such exercise.
3. Neurologic changes. For some unexplainable reason weight bearing on the feet seems to overcome marked clonus and involuntary mass movements seen in recovering cord injuries. We have had two patients who made no attempt to stand or walk because of marked clonus who improved remarkably and went on to complete recovery upon a program of forced weight bearing.
4. Improvement in general nutritional vasomotor functions. We feel that the resumption of the upright position is a great benefit in the general bodily tone and cardiovascular status.

We have nothing new to offer in ambulation except a program which consists of the following:

1. Exercises to strengthen the muscles of the upper extremities used in crutch-walking with particular attention to the triceps and muscles of the shoulder girdle. These exercises are commenced as soon as the patient enters the hospital and are continued throughout his stay. They are given by the Reconditioning Service.
2. Braces are ordered on the patient while his bed sores and bladder are being treated. In cord lesions with little or no function in the abdominal musculature, a thoraco-pelvic girdle is necessary. This consists of semi-circular padded steel bands engaging the rib margins above and the pelvic crests below. The legs are attached by free hinges at the



hip with the joints placed opposite the tips of the greater trochanter. The encircling thigh bands consist of a wide metal band posteriorly and wide canvas or leather straps anteriorly. An important point in the construction of the brace is to make the upper border of the upper-most posterior band parallel to and at the level of the gluteal crease. Drop-locks are used on the hinges at the knee but the ankle motion is free. This allows flexion at the hip and knee while the patient is sitting in a chair and locking of the knees while walking. The toes of the shoes are turned inward about 10 to 15 degrees in order to shorten the arc of travel that the foot must go through with each simulated step.

3. Walker. The standard army walker is used with a crutch type arm support.
4. Crutches about which nothing need be said.

Patients with high lesions require prolonged and tedious instructions in the art of paralytic walking. Normal walking is a complicated process in any biped animal. Steindler (1) describes the normal human gait as a constant alternating play between the two lower extremities in which they alternately assume the function of support and of propulsion. The only phase of the normal gait seen in a paralytic is that which takes place as the non-weight bearing extremity is allowed to swing, like a pendulum, forward; the paralytic gait is, therefore, fundamentally a succession of alternating pendular movements. Propulsion is obtained by the triped action of each of the two crutches and the braced lower half of the body. It is impossible to take up all the details of paralytic crutch walking but this much may be said at this time. Such walking involves swinging the pelvis and lower extremity by either the thoracic cage or the abdominal musculature, the force being transmitted through the braces. Since the gluteus medius muscle is paralyzed, it is necessary that the patient lean far to one side in order to raise the opposite extremity off the ground. This makes a grotesque over-movement at first which requires long practice before it is eliminated. These patients are frequently inhibited by a strong fear of falling and it may be necessary to deliberately allow the patients to tumble. When he finds that his sensory organs in the paralyzed region are no longer functioning, he will get over a great deal of his fear.

We feel that any patient with a cord lesion at or below D-10 should be gotten into braces promptly and without waiting for recovery of muscle function below the lesion. We feel that we can extend to such a patient the hope of ambulation with crutches provided his upper extremities are intact. We furthermore feel that patients with cord lesions as high as D-2 (provided their upper extremities are intact) may with prolonged practice and instruction be able to get around in braces, but to these patients we give a more guarded prognosis as far as walking is concerned and at the same time get them into braces and walker.

It may be that in the future, some as yet undeveloped operative procedure (such as thoraco-pelvic fascial slings) and the application of knowledge gained from the treatment of poliomyelitis may make it possible for these higher cord lesions to get about with crutches. As yet none of these have been used to our knowledge.

For those patients with high lesions unable to use the walker, we initiate a prompt wheel chair program. We feel that the simple change of posture and the additional exercise incurred in moving a wheel chair are a great benefit to the patient.

The question of amputation of the lower extremities for irrecoverable loss of function as in paraplegia has been raised; the Library of the Surgeon General contains no references to such treatment. The Council on Physical Therapy of the American Medical Association (2) advises that amputation be performed only if simple amputation will offer a better prognosis in terms of appearance, comfort and function and if a sufficient part of the extremity possesses enough useful function to work well in a prosthesis. Certainly very few, if any, cases of paraplegia would meet these requirements unless complicated by extensive bone or vascular damage.

In summary, therefore, early initiation of a program of ambulation in paraplegic patients raises their morale, furnishes invaluable physiotherapy, may overcome clonus and mass-movements in partial lesions, improves the nutritional state and vasomotor tone. Such a program consists of exercises for the upper extremities, the early fitting of braces, and supervised instruction in paralytic ambulation, starting in a walker and progressing to crutches.

Bibliography: 1. Steindler, Arthur: Mechanics of Normal and Pathological Locomotion in Man. Baltimore, Charles C. Thomas, 1935.  
2. Council on Physical Therapy, A.M.A., J.A.M.A. 116: 19 - pp 2159-60, 10 May 1941.

Major Prather - The next speaker will be Lt. Colonel David H. Poer who will speak on "Daily Care of the Paralyzed Patient."

Lt Colonel D. H. Poer:- The days when the patient who had received a spinal cord injury with resulting paralysis was treated as a troublesome and hopeless invalid, waiting for a kind, benevolent and perhaps desirable death, are definitely and irrevocably over. The men of the Army Medical Corps can point with pride to the fact that they have led the way in bringing about such a complete reversal of this attitude, and action, and that they have met the issue with all the resources of the entire medical profession. Nothing has been spared to give these unfortunate individuals the best opportunity to live their lives in some degree of comfort and happiness, based on their ability to get about and to perform some profitable occupation.

This performance has not been carried out by such a relatively easy method as sending out a generous check each month with assurance that it will continue throughout life. It has been brought about by developing and following a plan which is adaptable to the needs of each individual patient and is also capable of inclusion of all improvements that have been found to be of value.

The basis for the everyday routine in caring for the paralyzed patient in this hospital is the purposeful development of a strong patient-doctor relationship, the value of which to all soldiers having been emphasized by recent Army directives. All matters of every nature, all decisions whether professional or otherwise, all supervision and management is directly the responsibility of the one doctor-officer under whose care these patients are placed. All personnel responsible for the care of these patients work directly, insofar as is possible, under his authority and certainly he must, at all times, be familiar with everything that is being done for his patients, regardless of relative importance. Every single thing, however small it may seem, that happens to this patient is vital concern to him and he must be kept well informed at all times. This relationship becomes of inestimable value to the patient himself in that he finds that he has a firm fixed post to tie to and actually to spring from, on his road back to a reasonably satisfactory mode of living.

The time and method by which the doctor establishes, fosters, builds up and cements this relationship is during the daily ward rounds. These must, first of all, be regular and systematic, meaning at least once daily, including Sundays and holidays (perhaps even more important on such off days). Such rounds are necessarily time consuming since each patient must always feel that you have plenty of time to listen to all his complaints and to make and carry out any required changes in treatment promptly. Other rounds made in the evening have proven of immense value since those hours are usually free from the hurry, bustle and rush of the average hospital day and it is during these periods that the patient soon learns to know that his doctor not only knows his problem but also knows the solution. The complexity of the problem of the paraplegic requires this unusually time-consuming program but it pays large dividends in a manner not to be obtained otherwise.

In sponsoring such an inclusive arrangement, we would not for one moment presume that such a doctor holds the entire responsibilities in his hands for the many details of the professional, nursing and reconditioning care of these patients. The reverse would be more true. Certainly in no other condition are so many services of trained specialists required in each and every field of therapy involved. For that reason, we have started with the most important member of this treatment team who is the hospital corpsman or ward attendant, whose work takes him so close to the patient and who cares for the most per-



sonal details of ones daily life, including the movements of the bowels and the funtions of the genital organs. To do this we have given these men and women special training in the handling and care of paralyzed individuals. By such a method the doctor can rest assured that every detail of the daily care is not only carried out well in itself but also in a sympathetic and cooperative manner with the many other branches of treatment required. For example, in giving an enema, the corpsman bears in mind the position usually required, the location of decubitus ulcers, the usual time for meals, visitors and amultitude of other details. With such a schooling he knows the needs for satisfactory results from an enema, and what will happen if satisfactory elimination is not obtained.

The duties of these attendants are chiefly concerned with the proper care of the bladder and bowel, changes in position of the patient and aid in ambulation. Assistance is also given in the changing of bed linen and mattresses, and in feeding the patient. The use of special frames for turning the patient (Stryker) have not been found necessary when the attendants carry out their duties properly in shifting the areas of pressure on the body. Much more could be added about the extreme importance and value of the work done by these men, and after proper performance of duty they should not and will not go unnoticed or without thanks.

The next in this important therapy group are the technicians and now the separation into specialties begins. It would seem that there are specially trained men and women to do practically everything beyond the daily care mentioned above. Technicians carry out proper physical therapy and all this work blends readily into a reconditioning program consisting of such exercises that will give the individual the necessary massive shoulder girdle to substitute for leg motion. Special urological technicians or male nurses carry out all but the simpler procedures necessary to keep the urinary tract free from infection, draining properly, and to aid in the development of automatic bladder function. The functions of the dietitian have been enumerated by others and can be repeated for emphasis. Brace makers, Red Cross social and recreational workers, librarians, education and vocational instructors are some of the many workers needed.

This brings us to the nurses who share very closely with the doctor in the daily care of the patient. She also shares with him the responsibility of carrying out the necessary details of treatment, must be his listening post and intelligence department to acquaint him with all information, to advise and to make suggestions as are needed in order to obtain the desired results. Medications must be given on schedule without favor and with an eye on the development of drug habits of one form or another, particularly opiates. She must supervise the work of the attendants and technicians to see that vital points in therapy are carried out properly.

In addition to the important social and recreational program carried out for these patients by trained Red Cross personnel, attention must be paid to their religious needs. Daily visits by the chaplains are made and every effort is made to take the patient to the various chapel services where he mixes with so many other people. Personal guidance and counsel are provided to take care of all legal business matters as well as domestic problems where adjustments must be made by wife, children and other family members. An educational program is set up to fit the needs of each individual and this must fit into the voational plans to provide a livelihood after discharge.

We now return to the medical profession to complete the circle of therapy originally outlined, and we turn to the many specialists whose services are required to give a patient suffering with such a complex condition the best opportunities to obtain the most rapid conversion to comfortable and independent living. This entire symposium has been made up of discussions by these men so that one scarcely needs to repeat their part in the program. Since the original injury is to the spinal cord, it is with the neurosurgeon that the launching of the original plan must rest. Nearby, the urologist has more actual daily contact with the patient until an automatic function of the bladder has been established and infection brought under control. The internists, especially the nutrition expert, has his important function, the results of which are hastened by successful plastic surgery by closure of the decubitus ulcers. The orthopedic and the general surgeon likewise have their part in the treatment of associated conditions or complications, the more important of which have been discussed this afternoon.



Practically nothing has been said about the field of research which has opened by the study of the results of this type of injury to the individual. The control of decubitus ulcers has been partially solved by increase in our knowledge concerning protein and nitrogen metabolism and attempts are being made to control or prevent infection in the urinary tract. The sulfa drugs and penicillin have certainly been of inestimable value, but the problem of the gram-negative organisms remains. Further information concerning calcium metabolism is required, as well as all metabolic processes in paralyzed tissues.

The problem of ambulation must be studied to provide mechanical methods more adaptable to needs of the patient. The question of amputation of helpless paralyzed limbs has been raised, and may require trial in the patient with the necessary degree of thigh flexion remaining intact. Many improvements in wheel chairs and mechanical walkers are certainly to be expected when American genius turns to the problems.

Little has been said purposely about the special morale program required to initiate and bring about the most successful results in the treatment of these unfortunate individuals. Misinterpretation of such a program might result in too much of a Polly Anna attitude and all of us know the viewpoints of the average "G.I. Joe" to such a program.

It is our viewpoint that good morale in a paraplegia ward can best be obtained by treating patients in groups and perhaps later in a specially constructed and equipped colony where they can become selfsupporting and by following scrupulously the outline given above. This will readily convince the patient and his family that everything is being done to (1) cure his immediate ailments, (2) to get him to walking again, (3) to develop a degree of bladder and bowel control, (4) to teach him a gainful occupation and (5) to discharge him promptly, and after that the morale factor of the paraplegic becomes no factor whatever.

MAJOR PRATHER:- "The Future of the Paraplegia" will be discussed by Lt. Colonel Caleb S. Stone.

LT. COLONEL C. S. STONE:- On the first of May 1945 there remained on the paraplegia ward at Wakeman General Hospital, 36 patients with paraplegia resulting from spinal cord injury. These patients were all admitted subsequent to the first of August 1944 and most of them between August 1st and December 1st. Of this total, 26 will remain paralyzed in one or both of their lower extremities (71%); 22 will remain paralyzed in both lower extremities (60%). It is the group of 22, who will remain completely paralyzed in both lower extremities, that this discussion is most concerned with.

All of this group of 22 were underweight upon admission to the hospital, all had catheters in place, most of them suprapubic, all showed alterations in serum protein levels and AG ratios of greater or less degree. Most of them had bed sores and all were discouraged, despondent and forlorn. Some of these patients were received as little as three weeks after being wounded, some were received as much as two to two and one-half months after injury.

The general plan of treatment carried out on these patients has been outlined in principal by previous speakers on this program. These patients have been under observation now for a period of time varying from nine to three months. In addition to the details of treatment and specific procedures that have been carried out which have mainly to do with the immediate care of the paraplegia, we have made certain observations that have to do with the late care and the ultimate disposition of this group of patients. What we have learned about them can be listed under four headings:

- a. Physical condition.
- b. Mental attitude.
- c. Domestic adjustment.
- d. Economic adjustment.



Under the heading of physical condition, we have been impressed in our group with an apparent leveling off of improvement after about 4 to 6 months in the group of patients received without bed sores. In the group of patients who had bed sores upon admission to the hospital, this leveling off has apparently come about 2 to 3 months after the healing of bed sores. It is our feeling that the general physical condition, the degree of muscular development, particularly of the shoulder girdle, at this time is completely inadequate to permit these patients to enjoy tripod walking except for short distances and then only at intervals. Their physical resistance and their muscular strength needs to be greatly increased if they are to become sufficiently ambulatory for crutches and braces to be worthwhile.

We have been also interested in the ability of these patients to withstand sitting up in a wheel chair for long periods. It is our impression, based upon observations in this group, that these individuals can remain up in wheel chairs for periods of 8 hours or more, day after day, provided they are not engaged in any endeavor which absorbs their interests. When sitting about the ward or at the movies, visiting at the bedside of a fellow soldier, these men are observed to be constantly shifting their buttock, frequently shifting the weight and relieving the pressure of continued sitting. After starting a work program on the paraplegia ward, the patients interested in this activity who sat in a wheel chair at a work bench, became interested in their labor, they concentrated on production and in their effort to meet a production level per hour, they sat without shifting their weight and in two instances, superficial lesions developed on one buttock. It is true that in each instance, these superficial lesions may have been precipitated by the patient having bruised the buttock on the arm of his wheel chair in moving himself from the bed to the chair. Nevertheless, the patients themselves state that they find it more comfortable and they consider it necessary when at work to stop at frequent intervals to shift their position and relieve points of pressure.

We have been interested in the patients ability and willingness to begin to care for himself. We have accomplished little in this regard, at the time when the leveling off of his improvement occurs. As muscular development increases, patients have been encouraged to move themselves from bed to wheel chair and from wheel chair to bed. This requires, in many instances, particular muscular development in the shoulder girdle and it will require especially further consideration of the relative height of the bed and the wheel chair and overhead frame which the patient can use to grasp as well as modification of the type of wheel chair now in general use. Patients have been encouraged to take their own shower baths, using a specially constructed chair which can be rolled under the shower. Proper facilities are not available for the training of these men to take tub baths; even though this ability is desirable. Further, it would seem desirable not only to develop the muscles of the shoulder girdle and upper extremities to a sufficient extent, but also train the individual so that he might enjoy some form of locomotion in the event of necessity which would not require braces, crutches, wheel chair or the assistance of some other individual.

If the patient suffering from paraplegia ever hopes to return to a productive life, it might be well to institute a sufficiently long program designed to determine how long he may safely sit at work and by training, increase to the fullest extent his ability to sit at a bench.

An attitude expressed by many of these patients is that they would never consider going to their homes so long as they are unable to care for themselves, with regard to bowel and bladder requirements. It would seem, therefore, that every opportunity to develop an automatic bladder should be offered these individuals, that every opportunity also be offered by means of close dietary management, the development of habit, the training in the art of administering their own enemas and the supply of proper equipment necessary so that these men can care for their bodily needs without the assistance of other individuals.

We are apprehensive that certain individuals, now able to maneuver themselves in braces on crutches, will lose this ability because of too great an increase in the weight of the body incident to the deposition



of fat. It would be advantageous therefore to instruct these individuals properly to their choice of diet and proper exercise in order to prevent occurrence of this limitation in the future.

**Mental Attitude** - All of the patients in this group soon learn that they will not only remain paralyzed in their lower extremities but will remain without sexual ability. In the beginning, their outlook upon the future is bleak. These patients can be divided into two groups:

a. A group of younger patients - 19 and up - many of whom left high school to join the Army; they are unmarried but most of them have an immature attitude toward the problems of life. The main thought in the minds of this group is that they want to go home. These men have few, if any, responsibilities and in view of the pension policy of a generous government, they seem little concerned upon the future.

b. The other group is an older group - 16 of our 36 patients - are married, 9 of the 16 married men have children. All the men in this group also want to go home, if possible. They are very concerned less they be an undue burden upon their families. None of them wish to be dependent and those with children are concerned that the bounty of the generous government will not be sufficient to meet the responsibilities of a married man with children.

We have noted that as time goes by and function does not return, these men become fretful and critical. They are relieved when the truth of their future is explained to them. Their mental attitude responds best to a sympathetic personal interest in their individual problems; they respond best when they are given something to live for, something productive, something that they may use later on as a means of meeting their responsibilities.

In the group of men that arrived in our hospital of September 44, an interesting development was noted. After about five months, those men without bed sores became restless rather suddenly. It was noted that poker games were frequent occurrences on the ward, the patients turned out their lights at a later hour, they slept poorly and they were irritable. About this time, a work program was begun on the ward and an opportunity was offered every man to work at piece work which paid 60 or 70 cents for an amount of work judging to be a fair production for an hours labor. As this program developed, it was noted that poker playing fell off remarkably, patients began to go to bed early, they volunteered the information that they slept better. These changes were spontaneous and may well be due to the simple fact that productive improvement was offered in place of idleness. It might be interesting to state the reasons why different men in this group are interested in working for money: one man wants to buy a tube metal collapsible wheel chair for himself; another man needs money with which to help his wife and child; another is sending his meager earnings to his children; some work merely to pass away the time; one or two are interested in the game of increasing the work output and the monetary income of the ward each week; others, who held good positions in plants and factories, are working hard and at a salvage job primarily to impress employers that a man consigned to a wheel chair is capable of turning out excellent work; some claim they are only interested in helping to create a better situation for others who are to follow; one man refuses to work in the program but does work in the occupational therapy shop each day, his reason being that he is only interested in work that is creating or in a job that when completed, leaves him with an object that he has made that can be used as it is. The overall picture is that productive employment has added tremendously in meeting a problem of mental readjustment of recently paralyzed individuals.

**Economic Adjustment** - We have learned much from our small group about the economic adjustment that will be necessary. It may be plainly stated that some of these patients, particularly the younger untrained and unmarried individuals, feel that the pension of \$150 per month, plus the \$100 a month allowed for an attendant that will be paid by the Veterans upon discharge from the Army, will always be adequate to meet their needs; others are anxious for work because they need the additional income. Among our small group, there are three men who have been promised jobs by their old companies, provided they are ambulatory in wheel chairs; two men come from families who own a business in which the soldier can be productively employed in a wheel chair. It seems therefore that further efforts to rehabilitate and re-educate



the paraplegia, is a responsibility that should be met because a reasonable percentage of them can, if rehabilitated, adequately return to gainful employment.

Domestic Adjustment will be difficult. Obviously single men in this group will rarely marry unless they are picked up by someone seeking a meal ticket. Doubtless many of the married men will separate from their wives. Some of the married men who have children will not separate from their wives because of the children. In any event, this is purely a personal problem. The responsibility of a governmental agency could only go so far as to provide a man with the necessary physical reconditioning and training so that he may meet his responsibilities in this regard and thereby be best prepared to settle his personal problems in whatever way the parties concerned most desire. We have not yet had the opportunity to discuss this problem with the wife of a paralyzed soldier and perhaps we should never attempt it.

Plan - Since the subject given to me for this discussion is "The Future of the Paraplegia" I may be justified in offering a suggested plan for the care of the paralyzed soldier, based on our observations with a small group of patients but a group which may well be considered a cross section of the total number of paraplegias. It would seem therefore pertinent to suggest that the Army create a center for the rehabilitation of the paraplegia. If an adequate number of beds could be made available and an adequate staff, it might well be that patients yet to sustain injury of the spinal cord could also be best treated during the early stages of their disability, in such a center. The primary purpose, however, of a center for the rehabilitation of the paraplegias should be:

a. To accept patients after initial definitive care has been completed. One might estimate that the average stay in such a center would run from 8 to 12 months.

The purpose of such a center would be:

a. To complete the physical reconditioning of these individuals, to equip them with the muscular development of the trunk and shoulder girdle so that they might become completely ambulatory in braces or wheel chair, so that they might withstand the strain of continued physical effort while seated.

b. Re-educate. To educate these men so that they may become able to care for themselves in every respect possible; to give them vocational training suited to their ability, their past experience or to opportunities awaited them, or to give them the education and training necessary to open up for them new fields of endeavor, for which they have talent or desire, field of endeavor, which in the past have not been available to them, and finally in the overall to so rehabilitate and re-educate the paraplegia, that he may be able to return from the military service to a civilian status in his home without the necessity of being dependent the rest of his life upon institutional care, which at best doesnot give an individual any reason or purpose for remaining alive.

Such a center could it be established, should be placed in a suitable climate, one that permits outdoor activity pretty much the year around, where extremes of temperature are never encountered.

Such a center should be housed in one story structures to permit easy access to the outdoors to men in wheel chairs or on crutches. The housing facilities should be fire-proof, unless they are all one story structures close to the ground. If a multiple story structure is used, it would of necessity require adequate elevator facilities to permit moving rapidly many patients confined in wheel chairs. Such a center should certainly be on the main line of a railroad, it should be in a community where adequate and suitable housing facilities are available for the many visitors who should come to patients of this type. The necessity for a work program might well demand that such a center be placed with reasonable proximity to industry and also somewhat removed from a locality where labor is super-abundant.

Such a center, could it be established, would certainly require adequate personnel, both in training and in quantity. Neurological Surgeons, Urologists, Internists, and a General Surgeon would all be required in ade-



quate number in proportion to the number of beds occupied. In addition, properly trained physical reconditioning men would be necessary, an adequate brace shop, a large Physiotherapy and Occupational Therapy department, nutrition officers and dietitians would be equally necessary.

When one considers the vast number of questions raised by this group of patients, the answers to which are unknown, it becomes obvious that such a center should have associated with it an expensive, comprehensive research program.

The key personnel referred to would necessarily be men with an interest in and an appreciation of the problem of the paraplegia. Above all, such a center would require sympathetic, imaginative, and understanding direction from its Commanding Officer.

COLONEL R. H. KENNEDY:- Again let me say how pleased I am to be able to be present and hear the discussion of the particular subject of the Symposium. It has been of great interest to me throughout the war. I have been Chief of Surgical Service at two hospitals which were neurosurgical centers. I have seen the development of the program which has been planned to maintain the physical condition and morale of the patient. When we first received these patients, they came in rapidly and their morale was bad. Since the program was developed, I feel that, in general, the morale of the paraplegic ward is better than in any other ward in the hospital. It is the place which can be made the show place for distinguished lay visitors simply because of the morale of these men. It is a result of the work being done by all, from the enlisted men on up.

I went on a two months' mission last fall. When I left, the neurosurgical center had just been organized. On my return it had received about 600 patients and among these was a group of 39 paraplegic enlisted men and two officers. Their morale was bad, and it was hard to go into that ward. I was told by the Assistant Chief of Service that a youngster, a Lieutenant, had recently been placed in charge of this ward and he did not think he would be mature enough to handle it. The urologist worked along with him. We went through the ward and made out a list of two typewritten pages of suggested improvements. For a man from whom we did not expect a great deal, he immediately blossomed out in getting things done. One incident was the talk of the hospital. I went on a Christmas leave and found on my return that this youngster had gone to the Commanding Officer a few days before Christmas and said, "We've got 39 men over there on the paraplegic ward. Christmas is coming and many of these men have their families here. I don't know whether they'll be alive next Christmas or not but they're here this Christmas and I want every one of these men to have their families here for Christmas dinner." You can imagine what this did to a Regular Army Commanding Officer. The first answer was, "No". This ward officer was a First Lieutenant who had been in the Army four months. He said, "I demand that these men be allowed to have their families here for Christmas dinner. These men deserve it. They have given everything to their country. They deserve to have their families here and damn it, they're coming to dinner". I learned that they had 140 on that ward Christmas day for dinner. The Red Cross arranged for bridge tables at each bedside, with candles, fancy table cloths, comfortable chairs. When it came time to serve dinner, many of the enlisted men, WAC's and nurses from other wards volunteered to come over and help serve the dinner. It did a great deal for the hospital morale for this officer to insist on this being done. The most pleased person in the whole group was the Commanding Officer, who presided over the whole affair.

When you need more rubber tubing, irrigating bottles, walkers, etc., and are told they cannot be obtained, there is no such answer. These men have given everything and deserve more than any other men in the Army. Everyone should take the attitude that there is no such answer as "no" to their needs. I think the changing of personnel on the ward is the most difficult thing we have to deal with. The enlisted men, nurses and officers in charge should be left to continue in the same place. But don't forget that this is a terrific job that these people are doing and we have to mention the wardmaster and the nurses to let us know if they are feeling the strain. Some may stand it for six weeks, others six months. These people will stick because they have learned to love the cord cases so. We have to pull them out because they break themselves doing the job.



There has been little said about the dressing of wounds. Personally, I feel that it should be put in charge of some one person who will take an interest. The medical officer usually can't attend to all these cases and should make the ordinary dressings the responsibility of some one nurse. Make it a contest among them to take it as a personal thing, that it is up to them to get the wounds clean. I feel that patient officers sometimes do not get as good treatment as enlisted men. It is the same as in civilian life. You know that a patient on the ward often gets better treatment than a patient in a private room. It is the same in the Army. I believe that the officer paraplegic should be put on the paraplegic ward and see what the other men are doing. It is a big morale builder. You can't move these patients once they are in, but if it's taken for granted that, "This is the paraplegic ward, here you go", there's nothing thought about it. I wonder if it would be possible to keep in the service certain men at each one of the neurosurgical centers who are paraplegics themselves, who have been kept in the service as discharged hospital patients and who can stay around and train these men and be a morale builder among them, - somebody who has graduated from the course and knows the whole routine. There is more to be said on the subject of closing decubitus ulcers. I wish Colonel Shearer might be asked to say something.

LT. COLONEL THOMAS P. SHEARER: - Regarding the treatment of decubitus ulcers, I would like to congratulate Captain Barker on the beautiful results he has had at N. D. B. G. H. It is very interesting to note that there is little in the literature on the operative treatment of decubitus ulcer.

At Halloran General Hospital, Captain Croce, Chief of General Surgery, has devised a scheme for closing these ulcers by rotating full thickness grafts from adjacent areas. Our pre-operative management is much like yours, and seeks to obtain a cleanly granulating wound free from infection, and slough with fixed edges showing signs of epithelial invasion. Some of these ulcers are 12-15 cm wide and 10-12 cm long. At operation the ulcer is excised, then curvilinear incisions are made on either side both above, along the iliac crest, and below into the buttock. The large flaps so outlined are thus raised from the gluteal fascia. By rotating these four flaps toward the middle of the defect and approximating them to each other, the defect may be completely closed with a layer of skin and normal subcutaneous pad which thus far has seemed capable of withstanding all the abuse of the normal skin of that area. We have used a fine silk technique throughout with 000000 black silk.

We have had no experience with Thiersch grafts because we have felt that the treatment, as above outlined, is universally applicable, although some of the larger ulcers at first had to be closed in two stages. Moreover, we have felt that the end result is more durable than that of split thickness grafts applied directly over the sacrum. Some of the latter have broken down repeatedly until we covered them with sliding full thickness grafts as I have outlined.

We have come to conclude that operative wounds in these paraplegics will heal fully as well as they will in other young adults whether the wound lies in an anesthetic area or not: By the simple closure of the decubitus ulcer the nursing care is greatly reduced, the patient is ready for a more advanced program and his morale is greatly elevated.

COLONEL CLAUDE S BECK: - I should like to congratulate the medical officers who have taken part in the symposium on the paralyzed patient. What we have heard on this symposium should not be regarded as the last word. I would rather regard it as the first word on this subject. We are really only at the threshold in the care of these patients and I don't think we are going to stop where this symposium ends today. I think the subject has been covered in almost every detail. There are one or two points I would like to have additional information on. I would like to have a picture of what happened to the group of paralyzed patients in the last war; I would like to see graphs on the duration of life and the causes of death; I would like to know how many of the patients were taken care of in the Veterans Hospitals and how many were able to be taken care of at home. After they arrived at their homes, I would like to know what they were able to do, how much care they needed, whether any of them were able to earn a livelihood; I would also like to know something about the composite picture of experiences to date in this present



war. I understand that there are about 1000 paraplegic patients in this country at the present time and that there are also additional patients abroad. We ought to have a composite picture of the course these patients have taken up to the present time.

I think we have all been favorably impressed by the progress that has been made in the care of these patients. The picture, impressive as it is, is not as good as I would like it to be. I am disappointed in the matter of ambulation. These patients really do not get around very well. If they were to be discharged to their homes, I am very doubtful whether they would get around well enough to go out on the streets. Colonel Gage and I have been wondering about the advisability of bilateral amputation of the legs. Could the patient ambulate himself better if he did not have his legs? I should estimate the legs weight, 40 to 50 pounds. With complete transection of the cord, the legs are absolutely useless in ambulation. What they actually do is to elevate the center of gravity from the ground, a distance of about 4 feet, they act like a pair of stilts and the patient is in constant fear of falling. Should we not amputate the legs? If this were done, the patient could get around much better, he would have less weight to pull after him, he could sit on a platform which has wheels under it and ambulate himself by means of his arms, he could also get around in a small motor vehicle. I am aware of the fact that we are not attracted to this idea of leg amputation because the body is mutilated by this operation and we don't like to mutilate the body. If it weren't for this aspect of the problem, I think we would all agree that amputation should be done. It does seem to me that if any individual desires to have his legs amputated, that the operation should be done and the results recorded in the literature. Captain Cameron was asked to look up the literature on this subject and he told me that he was unable to find anything on this subject.

CAPTAIN J. J. MICHAELS:- A psychiatric associate of mine told me this morning of a dream that he had last night. He dreamed that he was a surgeon. If I had attempted to interpret his dream from a civilian standpoint, I would have asked him whom did he plan to "knife". After some experience in the Army and observing the spectacular and remarkable results that have been obtained by the surgeons, I would now interpret his dream as being very realistically motivated.

The proceedings yesterday took a downward direction in dealing with the neurological and the urological aspects of the patient with a spinal cord lesion. This morning the process was reversed and the direction was upward. I would like to direct my remarks to this higher level. This morning such factors as morale, mental attitude, patient-doctor relationship, and even the fear of fire were mentioned.

In the past, and recently, most studies and treatment have been directed to the paralyzed features of the patient. With such a serious illness it is right and imperative that such considerations come first. However, as we progress in the application of principles that we learn, it is necessary that we take into consideration how the patient reacts to his illness. In other words, I should like to discuss that our approach should be as much directed to the psychiatric aspects of the person as has been directed to the psychiatric aspects of the person as has been directed to his defective physical functioning, that is, the spinal cord injury. Regardless of how similar an injury may be, there are no two soldiers who react to it in the same manner. It should always be remembered that it is a specific soldier with his individual personality who reacts in his own particular way to an injury or illness.

One cannot help but be impressed by the tremendous number of individuals and agencies who have cooperated in the care and treatment of these patients. Their attitude has been most optimistic and their work most commendable. In the setting of the group and the realization that so many individuals are interested in the general welfare of the group, the morale of the group is high. However, if we listen to individual patients we find that they are more seriously concerned with their illness than might be anticipated by their superficial optimistic appearance. By the very nature of the condition, the patient is relatively helpless physically as far as his lower extremities are concerned if the lesion is in the thoracic region. If the lesion is higher he is also helpless as far as his upper extremities are con-



cerned. The awareness of such helplessness accentuates the psychological feeling of helplessness too. The majority of wounded soldiers can look forward to recovery and to a life of usefulness and happiness. Even the soldier with an amputated extremity can be rehabilitated with a prosthesis so that he can function adequately. The soldier with paralysis as a result of a spinal cord injury will, by and large, remain a chronic invalid. He probably will be sexually impotent, unable to marry or if married he may not be able to have children or rear a family. He may be prevented from carrying on a gainful occupation and unable to mingle freely in society. Major Elkins mentioned the problem of the intense pain that these patients may suffer and the need for bearing in mind the possibility of developing a future addiction to drugs. These two factors are of psychological import and need to be borne in mind.

In the soldier with a cord lesion the reality of his disability is very obvious. There is the objective fact of his being handicapped and failing in the ability to cope with life's situations. As a result it is natural to expect a certain amount of despondency and depression which are consistent with the reality situation. With such a great degree of disability when neurotic components develop, it is difficult to distinguish these subjective features because the objective aspects are so obvious. In contrast to the reaction of soldiers with paralysis, the soldiers presenting scars, deformities, and even amputations, although somewhat handicapped, are not as severely affected from a reality standpoint. Here a much greater degree of neurotic factors is present so that their reality situations may be considerably distorted.

During the hospitalization of these patients, they are surfeited with the attentions of many individuals. The suspicion arises that just as the patient tries to deny the seriousness of his condition and avoids facing his reality, so those who deal with him similarly may conceal from themselves the seriousness of the problem. This statement is not to dampen the ardor of optimism that has been manifested but to arouse the necessity of perhaps being somewhat more neutral and questioning what we are doing. Captain Cameron has indicated to what extent the morale of these patients rises as they find themselves learning to walk. Doubtless this is comforting to the patient and offers him something to grasp at. It is my feeling that the patient's despondency is not only related to his inability to walk but to the whole general picture of helplessness. He is unable to carry on in many spheres. It is not only an impotence in walking but the realization of a pervasive impotence in the spheres of sex, work and society.

Much effort has been expended in teaching the patient how to take care of himself. However, this teaching is more in the periphery of his personality, such as taking care of his bladder, bowels, muscles, appetite, eating, talking, and doing things with his hands. Such activities are of course necessary but it is believed that if the patient came to terms with the reality of his illness and settled this problem once and for all, there would even be a greater participation in his attempts at helping himself. The doctor-patient relationship mentioned by Colonel Poor might be more fully utilized by permitting the patient to unburden himself as to just how he feels about himself in his paralyzed condition. What ambitions of his have been frustrated? What kind of a world will he be returning to? Who will be able to concern themselves with him as has been the case in the hospital? To what extent can we help him overcome the psychological dependence that will have developed because of his actual physical dependence? He will have to learn to deal with his emotions in as independent a manner as he is learning to take care of his body.

In regard to Colonel Beck's provocative question of the possibility of amputating the lower extremities, one must evaluate the relative gains of such a procedure over psychological reactions to the loss of members of the body. Would we be adding another severe psychological trauma to the severe physical trauma already present? How will the patient react to being regarded as a cripple? How will he feel about his appearance?

In the Army there is a tendency to abbreviate, make short cuts and to use symbols wherever possible. The very nature of war with its emergency features may call for such terminology. However, military expediency may unwittingly bring with it certain medical disadvantages. For example, to

label a soldier an "amputee" tends to make us overlook the fact there is always the soldier as a person with an amputation. We regard him as an amputated individual, concentrating on the amputated part when we call him an amputee. In like manner, I would like to suggest that we always remember and refer to the patient who has a spinal cord injury with a resulting paralysis primarily as a patient with paralysis and not as a paralyzed patient.

LT. COLONEL MARVIN P. KNIGHT: - I would like to say from an orthopedic standpoint that Colonel Beck has something. One of my patients, a girl, had suffered from poliomyelitis since the age of 3, with the loss of the use of both legs. At the time I saw her the entire lower leg was some 18 to 22 inches in length. She walked with crutches very well. She could swing herself on a carrier a foot higher than her buttocks. I have seen other patients - one with an amputation of one leg above the knee, the other leg amputated below the knee. He walked very well and the only time you could tell that this individual had a prosthesis was by watching him go up and down a stairway.

Prosthetic appliances have been so developed, especially since the application of aluminum which makes them very light, that I would venture to say that a paralyzed patient here who can venture to walk 10 to 20 yards could walk a half mile following the application of a prosthesis correctly fitted. Of course, it is the problem of muscle transplants which have been carried out on poliomyelitis or infantile paralysis which aid an individual to hold his body erect as was mentioned in the first paper on this synopsis. With adequate muscle transplants from the abdomen and from the back, a patient's load would certainly be lessened following the removal of one or more so-called extremities. The average patient can become ambulatory as long as two hinges are involved, but when a third hinge or the pelvis is encountered, it is a very difficult problem.

CAPTAIN BORIS P. PETROFF: - I was especially impressed by the new appliances to help patients help themselves. We have established bars in the latrines so that the men can help themselves on and off the commodes but Lt. Colonel Stone's idea of a man taking a bath is a brand new one and we are going to try to emulate it as soon as possible.

Captain Michaels has been a great help to us on the ward. We had one patient with complete negativism after bad news from home and only treatment by Captain Michaels snapped him out of it. Another problem is this question of sex, which we all try to avoid. They can see, hear and feel and yet have no way of expressing the sex urge. Those married and who have children are always glad to see their wives. Those who are not married and those who have no children are greatly frustrated. By certain remarks they make, the pictures they draw and the statues they make, you can see what is going on in the back of their minds. It is most important to have the Neuropsychiatric Service help them to adjust themselves to the outlook of the future without sex life.

MAJOR PRATHER: - The next paper is entitled, "Post-Mortem Findings in Six Cases of Traumatic Transverse Lesions of the Spinal Cord", present by Captain Henry Rappaport, Chief, Laboratory Service, Nichols General Hospital.

CAPTAIN HENRY RAPPAPORT: - This is a brief report of six cases who died at Nichols General Hospital from complications of transverse lesions of the spinal cord (traumatic myelomalacia). All six patients were transferred to this hospital from overseas installations and arrived here from 33 to 106 days after injury. In five instances the fatal condition developed as a complication of the genitourinary tract infection. In the sixth case the patient died from a complication of a deep sacral decubital ulcer.

The following table presents a summary of the most important data collected on these cases:



	CASE I R. H.	CASE II J. B.	CASE III J. H.
Age	22	24	23
Level of Sp. Cord Injury	T <sub>3</sub>	L <sub>1</sub>	T <sub>3</sub>
No. of Days from Injury To Adm. to Nichols GH	33	106	58
No. of Days from Injury to Time of Death	73	290	157
Nutritional Status on Adm.	Emaciated	Undernourished	Undernourished
Decubital Ulcers on Admission	Severe, (sacrum and hips)	Moderate (heels only)	Severe, (sacrum, knees, heels)
Total Protein	4.9	5.3	5.3
A/G Ratio	0.55	0.63	0.64
Post-mortem Blood Culture	B. pyocyaneus	B. coli	Aerobacter aerogenes
Post-mortem Culture of Pus of:	Lung Abscess: B. pyocyaneus	Kidney Pelvis: B. coli Anaerobic streptococcus B. pyocyaneus	Peritoneum: Aerobacter aerogenes
Cause of Death	Lung abscess and gangrene due to septic infarcts originating from thrombosed pelvic veins.	Severe gastric hemorrhage, secondary to uremia and anemia, severe.	Intraperitoneal hem- orrhages due to spontaneous rupture of spleen.
Contributory Causes of Death and Other Important Post-mortem Findings	Empyema, right secondary to ruptured lung abscess. Peritonitis, subacute, with abscess formation, secondary to empyema. Malnutrition, severe. Anemia, severe.	Nephrolithiasis, right, severe. Pyonephrosis, chronic, right, severe. Status after nephrectomy, left. Perirenal abscess, chronic, bilateral. Malnutrition, severe. Anemia, severe.	Acute septic spleniti Perirenal abscess, left, secondary to pyelonephritis. Mul- tiple abscesses of spleen, secondary to perirenal abscess, left. Peritonitis, fibrino-purulent, acute, secondary to ruptured abscess of spleen. Malnutrition. severe. Anemia, severe.

Although these cases vary considerably as to their pathological manifestations, they have the following features in common:

1. The extreme emaciation at the time of death.
2. The severe secondary anemia.
3. A type of inflammation spreading by direct extension without respect for anatomical barriers such as fasciae, periosteum, serosal membranes or capsules of visceral organs.

	CASE IV D.M.	CASE V E.W.	CASE VI J.C.
Age	19	30	47
Level of Sp. Cord Injury	T <sub>2</sub>	T <sub>5</sub>	T <sub>11</sub>
No. of Days from Injury To Adm. to Nichols GH	70	41	80
No. of Days from Injury to Time of Death	195	132	132
Nutritional Status on Adm.	Poorly nourished	Fairly well nourished	Emaciated
Decubital Ulcers on Admission	Severe, (Sacrum and hips)	Mild, (one small ulcer over sacrum)	Severe, (sacrum and hips)
Total Protein A/G Ratio	5.6 Not done	Not done	Not done
Post-mortem Blood Culture	Hemolytic streptococcus	Hemolytic streptococcus	Hemolytic streptococcus
Post-mortem Culture of Pus of:	Perirenal Abscess: Hemolytic streptococcus. B. coli	Perirenal Abscess: Hemolytic streptococcus. Aerobacter aerogenes.	Abscess of Posterior Abdominal Walls Hemolytic streptococcus.
Cause of Death	Cardiac dilatation, severe, secondary to <b>rheumatic</b> heart disease and severe anemia of the myocardium.	Septicemia, secondary to perirenal abscess.	Septicemia, secondary to abscess of pos- terior abdominal wall developed by direct extension of inflam- mation from deep sacral decubital ulcer.
Contributory Causes of Death and Other Important Post-mortem Findings	Perirenal abscess, right, secondary to pyelonephritis. Septicemia, secondary to perirenal abscess. Malnutrition, severe. Anemia, severe.	Internal fecal fistula, (entero- <b>retroperitoneal</b> , secondary to gangrene of descending colon developed by direct extension of inflam- mation from decubital ulcer of left hip. Fecal abscess, retro- peritoneal. Malnutrition, severe, Anemia, severe.	Osteomyelitis, chronic, suppurative, of lumbar vertebrae, secondary to abscess of posterior abdomin- al wall. Pyeloneph- ritis, chronic, bi- lateral. Malnutri- tion, severe. Anemia severe



The type of inflammation found suggests very strongly a marked decrease of the general and local resistance to infection. This lack of resistance is further evidenced by the type of organisms found in three of the cases in which pure cultures of gram negative bacilli were recovered from the post-mortem blood (Cases I, II, and III). The same organisms were also found in the local lesions. In spite of the usual low pathogenicity of the organisms of the coli-aerogenes group they were apparently able to cause continued suppuration and septicemia in these debilitated patients. (Case II and III). It has been shown that resistance to infection is considerably decreased in hypoproteinemia and that, once infection develops, the regeneration of blood protein is much more difficult. (Madden et al). It is therefore suggested that the type of inflammation found in these hypoproteinemic patients was largely due to such lack of resistance, particularly lack of local tissue resistance. According to a recent publication the loss of tissue protein is much more severe than is indicated by the low plasma protein; the reduction of 1 Gm. in the circulating plasma is equivalent to a loss of 30 Gm. of body protein (Elman et al). It is suggested that the severe protein depletion of the tissues might account for their decreased resistance to infection.

All our cases developed anorexia sometime during the course of their disease and their food intake was inadequate. On admission to this hospital most of them showed evidence of severe malnutrition and had extensive decubital ulcers. In one instance (Case V) however, the patient was fairly well nourished on admission and had only one small decubital ulcer over the sacral region. He developed an unexplained anorexia of such a severity that his food intake became extremely inadequate. Clinically he was considered to have anorexia nervosa. He developed rapidly progressing decubital ulcers of both hips after admission. A direct extension of the inflammatory process from the left hip through the psoas muscle into the retroperitoneal space produced gangrene of the retroperitoneal portion of the wall of the descending colon. After perforation of the intestinal wall an internal fecal fistula and a huge retroperitoneal fecal abscess developed. A congenital megacolon occupying most of the anterior portion of the abdominal cavity was an incidental finding. The possibility that it might have contributed to the anorexia by compressing the stomach in the recumbent position and thereby producing a feeling of fullness after ingestion of small amounts of food was considered. This case illustrated the close relationship that exists between inadequate food intake, hypoproteinemia and lack of resistance to the type of infection described above.

Summary. Although the number of cases presented is small it seems to afford further evidence that there is a causal relationship between the degree of protein deficiency and the extent and severity of the inflammatory process. A vicious cycle is established whereby hypoproteinemia decreases resistance to infection and once infection develops the regeneration of body proteins becomes more difficult. Treatment should therefore be directed towards:

1. Maintenance of a good state of nutrition, with particular attention to the supply of large amounts of protein, starting as early after injury as possible.
2. Prevention of protein loss, particularly by effective treatment of decubital ulcers (e.g. early skin grafts).
3. Control of infection by adequate medical and surgical measures.

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MAJOR PRATHER: - The program will be continued. The next paper is entitled, "Urological Problems in the Convalescent Center", presented by Major Frank C. Hamm, Wakeman General Hospital.

MAJOR FRANK C. HAMM: - The Convalescent and Reconditioning Hospital has about 6,000 patients at the present time. The patients are divided into battalions of about 400 men each. The cases are placed in these battalions according to their principal diagnosis. At the present time there are five battalions Neuropsychiatric, four Orthopedic, two General Surgery, one officer patients, one Plastic, one Neurosurgery, and one General Medicine. The urologic cases are included in the General Surgical group.

As the soldiers come up for final disposition they are examined by various members of the staff at Wakeman. The urologic cases are seen in the Urology Clinic. At the present time we are devoting two full days a week to seeing these cases. The great majority of the cases sent down are carefully worked up and if there have been no recurrences of symptoms since admission, a final disposition is made. At these visits, X-rays, chart history, and patients are gone over. If new symptoms have developed, or a recurrence of the old, they may be admitted to Wakeman General Hospital for further treatment.

It is unusual to find cases in which pathology has been missed. In fact, I believe the urologist, in some instances, has erred on the side of working up the cases too well, if there can be such a thing. I refer to the occasional psychoneurotic who complains of indefinite pains in the back lower groins, and genitals. We have occasionally seen instances where more than one set of pyelograms have been done. In general, the work has been of a very high grade, and the results excellent.

We have recently discovered two cases in which the bullet was lodged in the perineum with the head projecting into the urethra at a point near the apex of the prostate gland. Their findings, except for the size of the missile and their complaints were almost identical, being that of a moderate dysuria, frequency, occasional nocturia, and a persistent pyuria. On Cystoscopy in both instances the nose of the bullet could be seen projecting into the urethra. In Case I, the location was on the right side, just proximal to the veru-montanum, and in Case II, just distal to it. Cystourethrograms were done to further localize the position of the missile. Case I was easily removed by suprapubic cystostomy, in which the finger readily found the bullet in the prostatic urethra, where it was grasped with a forceps. A previous attempt had been made to dislodge this with the cystoscope, but it was too firmly lodged and perhaps too large.

Case II, however, was prepared with a small dose of spinal anesthesia, and using the McCarthy Cystoscope a pair of duck bill grasping forceps, an attempt to grasp the missile was made, but it was not projecting quite far enough to grasp. A suprapubic approach is the next approach indicated.

It is difficult to establish criteria for the disposition of all types of diseases and injuries of the urinary tract. Our regulations, as outlined in MR 1-9 cover most of the decisions. Any type of chronic or recurrent urinary infection, and all cases of recent genital urinary tuberculosis should be separated from the service.

We have recently seen a good number of battle casualties, in which a nephrectomy had to be done. Most of these cases are associated with chest or abdominal wounds. I recently saw one soldier who had had a left nephrectomy, spleenectomy and several perforations of the bowel. In general, any disease or injury involving extensive surgery to the urinary tract is considered as being disqualifying for the Military Service.

Our relationship with the Convalescent Hospital has been very interesting. It is a valuable opportunity to see a larger group of war injuries to the urinary tract than one would see otherwise.

MAJOR PRATHER: - The discussion of these papers will be as a group as soon as we have finished the urological subjects. There will be a slight modification of these papers. We will now have Captain Clay Miller, who will speak on "Surgical Urology from the Viewpoint of the Army, Including Congenital Anomalies of the Urinary Tract and their Treatment".



CAPTAIN CLAY C. MILLER: - I would like to preface my paper with a few remarks - In case you might misconstrue our stern attitude toward these patients, I wish to emphasize the fact that it was our duty to deal with them for the good of the war effort, and in no way wish to detract from the place in the sun the good soldier so rightfully deserves.

The entrance of this great nation into World War II came abruptly and the necessity for rapid, immediate, and total mobilization was thrust upon us without warning. The scope of this project was so enormous that many physical defects of our draftees were totally ignored or not discovered by the examining civilian physician. Consequently, the surgeon of the armed services was soon to be confronted with multiple problems that he, and he, alone, must solve. His decisions were at times to set a precedent, which might, or might not be, of value to the Army, and the progress of the war effort. His judgement was to be questioned, coerced, and maybe condemned. Thus, the surgeon of World War II met and grappled with such problems so commonly seen by all of us who have served in large station or general hospitals of the Army.

The discussion of these urological problems must, of necessity, be based upon personal experience and I shall endeavor to place before you a composite picture of these conditions encountered, our judgment in handling them, our results, and our conclusions.

Eighteen months of my Army service were spent as Chief of the Urological Section of two large Army installations, Camp Atterbury and Campbell Station Hospitals. Through our dispensaries flowed the common urological problems, such as - varicoceles, hydroceles, urethral strictures, peri-urethral and prostatic abscesses, renal, ureteral, and bladder calculi, pyo-nephrosis, calculus pyelonephritis, TB of kidney and epididymus, hydronephrosis, hydro-ureter, nephroptosis, undescended testis, simple cysts of epididymus, tumors of testicle, hypospadias - 1st and 2d degree, horseshoe kidneys, complicated by renal calculi, pyelectasis, hydronephrosis, hydroureter, and infection, diverticuli of the urinary bladder, duplication of the ureter and kidney pelvis on one or both sides, and last, but not least, from the standpoint of congenital anomalies, one case of pseudo-hermaphroditism.

While assigned to Atterbury, in 1943, the problem of varicocele was paramount and within a period of about five months we had done some two hundred cases. We found it necessary to hospitalize these patients for a period of thirty to sixty days and invariably they continued to return to the dispensary with varied and sundry complaints, such as pain in the regions of the scrotum, pain in the groin, pain in the testicle, discomfort in the testicle while walking or standing, pain along the cord - that the testicle on the affected side was smaller than the opposite one, and occasionally a patient would relate in great detail how bitterly he had suffered during a long hike with a peculiar type of pain that arose in the testicle and progressed upward to the lumbar region. So annoying to us was this constant bellyaching of these individuals, before, during, and after this surgical procedure that by the end of the second month, or thereabouts, we decided to make a careful study of the next one hundred cases, pre- and postoperatively. Our plan of attack and results were, briefly, these: We formulated a short questionnaire and, for the sake of clarity, I shall tabulate the questions asked and the answers in percentage as given to us.

1. How long has this condition been present? - 100% stated that it was first noticed about the time they were 14 or 15 years of age.
2. When did this first begin to trouble you? - 90% stated that a short time after entering the service.
3. How many times have you consulted a physician regarding this condition prior to entering service? - 96% had never troubled to do so.
4. Did you ever participate in athletics? - 90% had.
5. What was your occupation before entering service? - 56% were doing manual labor.



6. Do you wear a suspensory at all times? - 97% had never done so prior to induction.
7. Does the suspensory give you any relief? - 75% thought that it did, but that it was very uncomfortable and unsanitary under Army conditions.
8. Do you wish to be operated upon? - 98% said yes.
9. How do you account for the fact that this condition never bothered you until recently? - Invariably there was no answer.
10. How do you like Army life? - The answer was "not very well" in 98%.
11. Do you feel that you have been benefitted by your operation? 10% thought there was some improvement.

Thus, after several months of such bitter experiences with these conditions, we arrived at the conclusion, as did the Surgeon General's Office a little later, that this procedure should be stopped. In our way of thinking, this was a wise decision.

The problem of hydrocele ranked second on our list and even though we know, in our own minds, that the patient had benefitted 100% as he would have in civilian life, we soon learned that tapping of these conditions on the average patient was a much easier procedure and certainly provoked less headaches for us as well as the Army. At least we eliminated the frequent postoperative trip to the dispensary with the patient pointing out the painful, enlarged induration about the epididymus.

Our experience with the surgical management of strictures of the urethra, which necessitated an internal or external urethrotomy, or both, was most gratifying. These patients usually entered the hospital suffering from an acute retention and many were having severe pain - the sudden and complete relief and the fact that they could pass their urine more freely than had been possible for years was, to them, little less than a miracle. To substantiate our finding in this - we so often found it necessary to call their Unit Commanders to send them in for follow-up treatment which was, of course, so essential to their permanent welfare.

Renal calculi were frequently encountered and the proper management of them was of no little concern to us. Many of these conditions were EPTS and in all sincerity we were, on many occasions, wandering in the realm of uncertainty. Briefly, I shall discuss our approach to this problem and our conclusions. We determined by careful examination, which included all, or any of the recognized urological procedures, the size and location of the calculus or calculi and the resulting damage to the kidney, if any. We then divided these, roughly, into two large groups - operable and unoperable. The former included those which we felt certain could be done surgically with the assurance that the soldier could be returned to duty within the prescribed period of time and with the minimum possibilities of bad postoperative sequelae. Into the former group we placed all calculi that could be removed through a pyelotomy incision, and those cases which required nephrectomy. Into the latter group fell those that required or would require nephrotomy, nephrostomy, or partial resection of the kidney. Our judgment was based upon the fact that in those conditions requiring nephrotomy we have two important and serious postoperative sequelae to consider - 1st - severe hemorrhage which may occur as late as the twenty-first day, and even necessitate nephrectomy. Secondly, the early recurrences of the calculus or calculi again requiring surgical intervention with resultant long hospitalization.

We approached the problem of ureteral calculi, bearing in mind the fact, as borne out by some of our nationally known clinics, that 40% of them will pass unassisted, that 40% will require manipulation through a cystoscope, and that the remaining 20% will require surgical intervention. Our first objective was to determine the location, approximate size of the calculus, and how much renal or ureteral damage was done, the condition of the opposite kidney, the possibility of non-surgical intervention which I shall discuss a little later, and how urgent was it that this obstruction be eliminated. The determination of the location, of course, was usually quite simple - as was the



approximate size. The possibility of the passage of this calculus, were it at all large, through the remaining portion of the ureter, we tried to determine by retrograde ureteral urography, which, for the lack of a better name, we termed calibration of the ureter. To our satisfaction we were correct in the majority of cases in which we felt definitely that the calculus could be passed with or without manipulation. In dealing with those requiring surgical intervention, our best results were obtained when the calculus was removed from the upper or middle third of the ureter, based upon the facts that the approach was easier, less traumatic as was the annoying postoperative sequelae that can and do occur with removal of stones from the lower third of the ureter.

Hydro-nephrosis and hydro-ureter, unilateral, bilateral, with and without demonstrable obstruction, were frequent findings in our department. Only in those cases in which we could definitely prove the etiology to be on a mechanical basis was surgery done. Those cases in which we could find neither congenital anomalies nor acquired pathology we felt were definitely on a neurogenic basis and strongly advised against surgical intervention.

Our experiences, and the observation of others, with the problem of undescended testicle have been most interesting and certainly most discouraging. We performed, in all, some three cases of orchidopexy, so early in our Army career did we learn the error of our ways. Not one patient, of whom I have any personal knowledge, on which this was done has made a useful soldier. In all, we have had the opportunity to observe some twenty-five cases, twenty-two of which were done by other surgeons. To us, the results were excellent, but to the patients they had been a total failure and their complaints were varied and bitter. In searching through their clinical records, one would find that they had visited frequently every medical installation to which they had had access, and on several occasions most of these individuals had been labeled as definitely psychoneurotic. Of this diagnosis I am not so sure, because a careful analysis of these cases reveals that the great majority had been operated upon in order that they might become combat troopers, and in all cases none had had any untoward symptoms prior to surgical intervention. In retrospect, would it not have been better to have placed these soldiers in non-combatant outfits rather than to have subjected them to surgery? Thus, we early condemned the procedure and believe that our decision was to be of benefit not only to the Army, but to us as well, realizing, of course, that our series was extremely small, being some twenty-five cases, but with a 100% failure as far as accomplishing our objective.

Malignant tumors of the testicle have been encountered much more frequently than we thought possible, as I, for one, have not seen too many in civil practice which included a large service in a charitable institution. The most interesting factors involved were that the condition in every case was first noticed following trauma, that the patient was not cognizant or disregarded entirely the developing tumor in the testicle, because he was sure the indurated nodule was the result of his former accident; that he hesitated to call attention of the condition to his medical officer, and the errors in diagnoses upon so doing, especially when the involved area appeared adjacent to the epididymus. Interesting too, was the finding that in all cases observed, the Ascheim Zondek test was repeatedly negative. In one case the breasts were markedly enlarged and tender - yet four consecutive Ascheim Zondek tests were negative. This finding coincides with that of Dr. Heller who reported a series of 50 cases of malignant tumor of the testis, in the February issue of the Kansas Medical Journal, in which he states that the diagnostic value of the Ascheim Zondek is limited. Interesting too, is the fact that we have not observed any benign tumors of the testicle. However, in spite of the fact that the great majority of our cases were far advanced, we were, at no time, able to demonstrate metastases. All were operated upon at once and as soon as possible were sent to a radiological center for deep therapy. We have had little opportunity to observe these patients since and the post-operative time is too short to evaluate our results.

Hypospadias, 1st degree, has been observed quite frequently and our policy has been, since one most unfortunate experience, to leave these conditions absolutely alone - the above-mentioned cases I feel warrants relating. This patient appeared at the dispensary, stating that he was married, and that due to the marked downward and backward curvature of the penis, he was unable to carry on satisfactory sexual relations with his wife, also that



the redundant dorsal prepuce caused much irritation about the glans penis. Realizing that were we to remove the redundant portion of the prepuce in order to correct his low-grade balanitis, we might refute any later attempt to correct the marked curvature, hence the decision to do a first stage operation -- which I have regretted to this day. Very simply the procedure was carried out, the longitudinal fascial bands on the ventral surface of the shaft - which, of course, caused his marked curvature were carefully dissected away, the redundant dorsal prepuce freed, button-holed and used to good advantage - the penis was splinted and primary healing occurred. The patient was discharged from the hospital on the fourteenth postoperative day - and then our troubles began. This patient visited us from once to twice daily, relating in detail every symptom that could possibly arise in conjunction with a flaccid or an erected penis - diseased or otherwise. Finally, in desperation, he was advised not to return for consultation, in tones that were not too inaudible. His next visit was to the Post Surgeon. Here, our narrative shall cease because I do not care to relate nor dare I place in print that one-sided interview.

Congenital anomalies of the middle and upper urinary tract were seen at infrequent intervals, with and without associated pathology. With very few exceptions these conditions were not surgical problems. We were privileged to see some fifteen cases of horseshoe kidney, 11 of which were found accidentally on other services during routine examinations. There was no complicating pathology of the condition and of course caused us little, if any, concern. The remaining four cases were all complicated by calculi, infection or both. One entered the hospital acutely ill, chills and temperature ranging from 102 to 104.6. The urine was loaded with pus cells and the culture revealed a colon bacillus infection. Sulfathiazole, gram 1 q4h, was given orally and within three days the patient was quite well again. A short time later an IV urogram revealed a large staghorn type of calculus involving not only a portion of the renal pelvis but also the inferior and middle major calices on the left side. Judging from the history of urinary disturbances prior to induction and the length of service the patient was given a Certificate of Disability Discharge. Another case was discovered to be suffering from a bilateral infected hydronephrosis and hydroureter, moderate, without definite evidence of mechanical obstruction. There was no history of previous disturbance which one could attribute to this condition, but under medical management the infection was brought under control and the patient was returned to limited duty. Two other cases were discovered on the orthopedic wards - each showing rather a moderate sized calculus within the renal pelvis, both were on the right side - there was only a very moderate degree of hydronephrosis present in each and in one case there appeared to be a rather definite narrowing at the uretero-pelvic juncture. There was a colon Bacillus infection present in both cases. We were tempted to remove these surgically - and - may be we should have, I honestly do not know. Interesting, too, was the fact that only 50% of these individuals presented the classical horseshoe kidney syndrome - of which the three main clinical factors are - (a) abdominal pain about the peigastrium or umbilicus, (b) history of chronic constipation with gastro-intestinal disturbance, (c) relief of the epigastric pain by leaning far forward.

Five cases, in all, of diverticulum of the urinary bladder were observed during the past twenty-eight months of service. One of these was symptomatic. This particular case was found to have a diverticulum equally the size of urinary bladder and was of the narrow neck variety. Surgery was instituted and the patient made an uneventful recovery. The remaining cases were of the wide neck variety, were not too large, and were asymptomatic, being discovered accidentally while undergoing complete general examinations. There was no infection present in the urinary tract of any of them - and our judgment was to do nothing surgically about them.

The one case of pseudo-hermaphroditism was extremely interesting. This was observed in a soldier some 18 years of age who was a large, husky lad, well developed, and with no other anomalies present that we could detect by a complete general examination. Nearly as possible I shall describe this condition - the scrotum and testicle were normal, except that the scrotum appeared to arise anteriorly a little too far, and the shaft of the penis appeared to arise between the folds thereof - although the shaft, glans, and urethra were quite normal except for this fact - that on the dorsal surface about 1½" from the base of the penis one found a depression resembling



a large ureteral opening through which protruded a rounded fleshy mass about the size of a lead pencil, and on pushing back the skin surrounding this, one found that it progressed downward and backward for about 1½" where it appeared to arise from the fascial septum that divides the corpora spongiosum. The boy was quite embarrassed about the condition and had never consulted a physician before regarding this - and had in some way managed to avoid detection during all previous examinations, reporting to us because of irritation that had come on following two weeks of constant field duty. The patient was operated upon and very simply this was removed at the base, the mucous membrane lining the canal was dissected away and the skin surfaces were approximated. Primary healing occurred. Our pathologist described this as tissue found in the normal clitoris. I, personally, have never seen anything that might in any way resemble it and of course, I wish to make no positive statements regarding it.

#### Summary and Conclusions

We, as Genito-Urinary Surgeons of the Armed Forces with little or no previous military training, have been subjected to a unique experience. We have been confronted with almost every common urological problem met with in civil practice - plus two large additional groups, namely -

1. The soldier, by the grace of God and an Act of Congress.
2. The soldier suffering from battle injuries to the urinary tract with about every imaginable complication. This latter group has been presented in a most interesting and instructive manner and I shall refrain from further discussion of that.

However, the former warrants close scrutiny, detailed study, observation and evaluation. As you all know and have seen on hundreds of occasions the soldier, and I hesitate to so name him, who would do anything short of mayhem to be relieved of military service, with a pension if possible. He appears on sick call daily, complaining of anything to which one will listen, and especially if he has anything tangible on which to base his complaints; such as a varicocele, a hydrocele, a simple cyst of the epididymus, and undescended testicle, a hypospadias, or any other pathology of his urinary tract which is known to him, and last but by no means least, a previous operation for one or more of these conditions.

Therefore, I feel that we as temporary military surgeons and future taxpayers of these United States cannot be too careful in our selection and performance of the elective surgery with which we are being constantly confronted. Also, in retrospect, I feel that had our Government required a rigid, exhaustive, complete physical examination of all draftees prior to induction, it would have saved an unestimable sum which has been spent in trying to salvage the physically and mentally unfit, and a staggering figure yet to be paid in unwarranted pensions.

May I, therefore, enumerate the following conditions, so commonly found in our inductees, which I believe should not be correct surgically, in the great majority of cases.

1. Undescended testicle.
2. Varicocele.
3. Correction of congenital anatomical anomalies of the urinary tract, such as horseshoe kidney, typospadias, and unilateral fused kidneys, etc.
4. Hydrocele.
5. Plastic operations for hydronephrosis and hydroureter.
6. Nephrotomy or nephrostomy for calculi, unless an emergency measure.

MAJOR PRATHER:- It is nice to hear an intimate review of experiences in the Army. The next paper will be entitled "Extraction of the Low-Lying Urethral Calculi by Improved Catheter Loop Extractor" by Major Abel J. Leader of Fletcher General Hospital.

MAJOR LEADER:- The success reported by those who have employed the flexible catheter-loop technique in the manipulation and extraction of low-lying ureteral calculi recommends the method to the attention of the urologist. The short period of time that has elapsed since its introduction has not permitted the accumulation of a large series of cases, but reports of others and our own experiences indicate that this is a satisfactory method of handling the problem of certain calculi in the pelvis segment of the ureter. It is the purpose of this communication to report eleven cases of calculus in the fixed portion of the ureter successfully treated by this method and to describe a simplified modification of the improvised flexible catheter-loop extractor described earlier by Balkus.

All flexible catheter-loop extractors thus far described employ a common principle. The first such instrument was described by Zeiss in the German literature in 1937. It was subsequently introduced in this country by Wehrbein in 1942 who devoted considerable painstaking effort in conjunction with one of the large domestic catheter manufacturers in developing the first flexible catheter manipulator in this country. This is an excellent instrument consisting of a nylon thread fastened to the distal end of a catheter, the thread returning through the lumen of the catheter by way of a woven eye approximately five centimeters from the distal end. Balkus in 1943 described an improvised modification of the Zeiss extractor employing a ureteral catheter and fine surgical wire. One end of the wire was fastened to the proximal end of the catheter, and traction exerted on the other end of the wire which returned through the lumen of the catheter resulted in the formation of a distal loop which engaged the calculus. Following an unavoidable delay in obtaining the commercial nylon thread extractor described above, we attempted to make one of the Balkus instruments but in our hands the winding and securing of the wire to the proximal end of the catheter presented technical difficulties. The instrument to be described was constructed by us on the same principle. It is a simplified modification of the Balkus catheter and possesses, we believe, added safeguards.

Other methods of extracting calculi by means of catheters have been described. Finney ties a silk ligature to the tip of a catheter which is passed beyond the stone and into the renal pelvis. Traction on the ligature causes the catheter to assume the configuration of a hairpin, and traction applied to the two ends of the catheter after the distal tip has been brought back down below the stone results in the extraction of the stone which has become engaged by the loop thus formed. The McKay instrument is a ureteral catheter to the distal tip of which four silk ligatures are tied. It depends for its success on enmeshing the stone by the ligatures when the instrument is withdrawn. The multiple catheter method involves the passage of several catheters beyond the stone after which they are twisted to enmesh it. We have not been able to extract stones with any degree of regularity by this method, but the dilatation of the ureter accomplished by the catheters results in the subsequent passage of the stone in a good percentage of cases.

#### THE FLEXIBLE CATHETER-LOOP EXTRACTOR

Our modification of previously described loop extractors requires no special skills in construction. It may be easily and inexpensively made from materials that are readily available. A plastic or woven nylon ureteral catheter is either the four or five French size, some .009 inch corrosion-resisting surgical suture wire, and a straight skin needle represent the materials required. Placing a whistle-tip catheter upon a flat surface with the distal eye upward, it is fixed with the thumb, index, and middle fingers of the left hand proximal to the five centimeter marking. The skin needle is then used to drill a perforation in the middle of the five centimeter marking in the same plane as the distal eye. Care is taken to make this perforation no larger in diameter than is actually necessary to permit the entrance of the steel wire into the lumen of the catheter. This minimizes the possibility of early breakage of the catheter at this point and thus prolongs the life of the instrument. To facilitate the introduction of the wire, the perforation should be drilled at a 45 degree angle. Following this,



one end of a length of wire measuring approximately twelve to fourteen inches longer than twice the length of the catheter is introduced into the newly made perforation and passed into the lumen of the catheter until it emerges from the proximal end for a distance of six to seven inches. The other end of the wire is then passed into the lumen through the distal eye until it, too, emerges from the proximal end of the catheter for the same distance. The five centimeter portion of the wire at the distal end of the catheter that is external to the body of the catheter is then closely approximated to the catheter by shaping with the fingers. The proximal wire ends are then knotted together and the excess beyond the knot is cut off. Thus, in the completed instrument the wire is a continuous loop which affords purchase for traction by the fingers in the formation of the distal loop of the catheter and in maintaining that loop by traction during the extraction of the calculus.

### THE PROCEDURE

This method is employed only for the extraction of calculi in the pelvic portion of the ureter. This segment is relatively fixed, and in it are found the so-called "anatomic narrowings" where the downward progress of the calculus may be arrested. These anatomic constrictions are (1) that point at which the ureter crosses the iliac vessels, (2) at the base of the broad ligaments in the female and the vas deferens in the male, (3) at the "juxtavesical constriction"-- that point at which the ureter enters the external muscular layer of the bladder, and (4) the ureteral orifices. We do not employ this method or any other involving the use of traction in the ureter at a higher level. Further, it is not our intention to imply that the method outlined is suitable for all cases of low-lying ureteral stone, or that the results obtained in a larger series will be uniformly successful. Successful manipulation depends on the ability of the operator to pass the catheter beyond the calculus. It is impossible to do this in many instances. In general, the stone must be in the lower third of the ureter, it should not be more than one centimeter in diameter, and it should not be encysted--present asymptotically over a long period of time. We also believe that the method is contraindicated in the presence of severe infection above the stone, for in such cases the hazard of severe injury to the ureter and of added infection are very real.

A good flat film of the abdomen is obtained. This gives information as to the position, size, and character of the calculus. If the criteria for manipulation and extraction are fulfilled, the patient is given the usual pre-anesthetic medication. A low spinal using 50 - 80 milligrams of procaine or a corresponding dose of metycaine is administered, and the patient is then draped as to cystoscopy. We have on occasion used intravenous sodium pentothal; anesthesia but we prefer to keep the patient awake if possible. The cystoscope is introduced and a number four French ureteral catheter is passed into the ureter and beyond the stone if possible, and as this is withdrawn, a small quantity of mineral oil is injected. The catheter extractor is then introduced and passed up the ureter beyond the calculus. No styilet need be employed as the double strand of wire in the lumen of the catheter imparts to it sufficient rigidity to enable it to by-pass the stone. With the distal end of the catheter above the calculus, the distal loop is formed by traction as shown. Before forming the distal loop, however, the operator first sharply bends the wires of the proximal loop as they emerge from the catheter so that traction will not completely obliterate the kink. Subsequently, the operator can be certain that he has formed the distal loop if the wires of the proximal loop become about three centimeters longer on traction. After the distal loop is formed, the instrument is slowly withdrawn, a steady pull being maintained. As the calculus becomes engaged in the loop, a sense of increased resistance to the withdrawal of the instrument is experienced. Continued firm and steady traction brings the loop and calculus down through the ureteral orifice and into the bladder, where the calculus usually falls free and can be washed out through the cystoscope. On occasion, the loop may come away from the ureteral orifice without the calculus, but a second attempt (and in once case a third) has succeeded in our series in all but two cases. In order to avoid unnecessary trauma to the ureter, we have arbitrarily limited ourselves to three attempts at extraction of the stone. In our series, neither preliminary dilatation nor ureteral meatotomy have been considered necessary; indeed, it is our conviction that routine ureteral meatotomy and/or fulguration with their possible sequelae of ascending infection and stricture formation are to be condemned.



Following the extraction of the calculus, two catheters are passed up the ureter and tied in for forty-eight to sixty hours. We consider this latter detail important, since the trauma incurred by the ureteral mucosa incidental to the extraction of the stone may produce sufficient postoperative edema to result in an acute and very painful ureteral colic. We routinely use two indwelling catheters because not only are they less frequently dislodged too early, but even should both catheters become occluded, urine can still pass down the sides of the catheters into the bladder. Postoperatively, forced fluids are the rule, and sulfadiazine with equivalent soda bicarbonate is given in half gram doses four times daily for five days.

## RESULTS

In our hands, the flexible catheter-loop extractor has been successful in eleven of thirteen cases. In several cases, two attempts were necessary, and in one the stone was delivered on the third attempt. In all cases in which the extraction was accomplished, the calculi were extracted at the initial sitting, and in none was prolonged traction on the proximal loop necessary; hence our satisfaction with this procedure for the immediate extraction of ureteral stone. In our first case, following conservative therapy including the use of the multiple catheter method, the loop extractor proved successful after earlier measures had failed. Subsequently, since we are charged with the responsibility of returning military personnel to duty as quickly as possible, we abandoned expectant forms of therapy and routinely employed the loop when the proper indications were present. We had as an additional incentive to the use of this method the knowledge that many of these cases were overseas returnees who had been evacuated to the zone of the interior because of incapacitating colics due to calculi which showed no disposition to move after a long period of watchful waiting and hoping that the stone would pass spontaneously. Further, the statistics in the separately reported series of Kretschmer, Higgins, and Wichard, comprising 1400 cases of ureteral stone indicate an expectancy for spontaneous passage of the calculus in only 18 - 20 per cent of the cases. We were fortunate in all instances but one in being able to by-pass the stone with the catheter-extractor. In this case, which we list as a failure, the calculus was pushed up into the upper third of the ureter ahead of the instrument. This was discovered by X-ray after two attempts had failed to bring the stone down. Our second failure is harder to explain: the calculus was possibly too small, and it could not be engaged in the loop. No stone in our series was too large to extract through the intact ureteral orifice. The following cases illustrate the employment of the flexible catheter extractor.

Case #1. A 46 year old major was admitted to our hospital by transfer from the station hospital at his post with a history of four months' duration of vise-like gripping sensations in the left lower quadrant and in the region of the left sacro-iliac joint, especially following exertion. Nine days prior to his admission to our hospital on 16 November 1944 and two days following participation in a bowling tournament, he was awakened by the sudden onset of severe colicky pain in the left lower quadrant and suprapubic region with radiation of the pain in the end of the penis. There was also marked urgency, frequency, nausea, and vomiting. After several hours, the colic had not abated and the patient was hospitalized at his post, where the administration brought relief from the pain. X-ray taken at this time revealed the presence of a calculus measuring  $\frac{1}{2} \times 1$  cm. at the left ureterovesical junction. Thereafter, despite recurrent colics, recheck X-rays indicated that the calculus had made no downward progress. Consequently, the patient was transferred to this general hospital for definitive treatment. Since we felt that the indications for the use of the catheter-extractor were clear-cut, the patient was given a low spinal anesthetic and the procedure as outlined above followed through. Although an obstruction was encountered approximately 2 cm. from the left ureteral orifice, the manipulator was passed beyond the calculus with only slight difficulty. On the first attempt, the loop came away without the calculus, but several small calcareous fragments were washed out of the bladder. On the second attempt, the calculus was recovered. Two ureteral catheters were passed into the ureter and allowed to remain indwelling for forty-eight hours. The patient left the hospital five days later, a final flat plate indicating that no portion of the calculus remained. It is interesting to note that this patient was a convalescent within three hours after his admission to our hospital.



(Figure 2. Demonstrating the Extraction of a Ureteral Calculus with the Radio-opaque Flexible Catheter-Loop Extractor).

Case #2. A 26 year old Air Corps officer was admitted to the hospital on 7 July 1944 with the history of onset on 20 October 1943 of sudden severe urgency for which micturition afforded only momentary relief, and an associated severe dramping pain in the left flank which he at first thought was a gas pain. There was no associated hematuria at this time. The patient, then stationed in New Guinea, was hospitalized and given morphine which relieved his pain. During the remainder of this hospital stay, the patient has no further symptoms, but examination of the urine revealed a microscopic hematuria. The patient was discharged with a diagnosis of hematuria, of undetermined etiology. Within 72 hours of his return to duty, he began to have attacks of left flank pain of about thirty minutes' duration and recurring two to three times daily. However, these were not associated with urgency or nocturia and only occasionally with moderate frequency. About one month after his discharge from the hospital, he was again hospitalized, this time because of the occurrence of a sudden gross hematuria. X-ray and cystoscopic studies were again negative, and the patient was once more returned to duty with the same diagnosis as before. Thereafter, he continued to have the same bouts of pain as before his second hospitalization, but he did nothing about it because he stated that he had learned to live with his pain. In January 1944, after 19 months' overseas service, he was sent back to the United States on rotational policy and not as a patient. He then remained asymptomatic for two months, but then began to have progressively more severe attacks of left flank pain, hematuria, urgency, and frequency. He was thereafter hospitalized on three different occasions, and only on the last was a diagnosis of ureteral stone finally made. The patient was then transferred to this hospital for definitive treatment. X-rays taken shortly after admission revealed the presence of an opaque calculus measuring 9 mm. in its longest diameter at the level of the sacro-iliac joint. Because of the prolonged incapacity produced by this calculus, the patient had by this time developed a mild anxiety psychoneurosis, and it was believed that early treatment was necessary if this officer was to be salvaged for further useful military service. The offending calculus was extracted on the first attempt, and within a short time the officer was returned to full duty status, his convalescent having been uneventful.

#### CONCLUSIONS

1. We are of the opinion that the flexible catheter-loop technique in the extraction of low-lying ureteral calculi offers promise of a higher percentage of successes than do other manipulative procedures thus far described.
2. The extraction of ureteral calculi by this method is relatively atraumatic.
3. This procedure has been employed by us with success in eleven of thirteen cases.
4. An improvised stone extractor is described which has the advantages of simplicity of construction from readily available materials, low cost, greater durability, and radio-opacity. The wire loop incorporated into the catheter imparts to the instrument sufficient rigidity to obviate the use of a stylet, and is in addition a safety feature in that the distal loop may be readily opened by the simple expedient of cutting one of the wires of the proximal loop, should this become necessary.

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MAJOR PRATHER:- These three papers are now open for discussion. Major  
Joelson, do you have any remarks?

MAJOR J. J. JOELSON:- I have no remarks.

MAJOR PRATHER:- Major Raines, any remarks?

MAJOR S. L. RAINES:- None.

DR. W. H. TOULSON:- Mr Chairman, I hate to get on my feet so much. I would like to take this opportunity very belatedly to thank Colonel Cook and his staff, Colonel Poer and all the other officers for their courtesy in having me here and for their additional courtesy in allowing me to discuss these very valuable papers. This has been a most interesting meeting. I am going back to Baltimore very much benefitted by having attended it. I would like to make a comment on Captain Miller's paper. We are all familiar with the scarcity of pulmonary tuberculosis in the Army. If my understanding is correct, it is probably due to the screening that was given the soldier's chest as he was inducted into the service. We are aware also that symptoms may be absent at induction and come to evidence later on in the soldier's training in the Army. I don't see how all of these conditions of the urinary tract can be avoided, but after listening to Captain Miller's paper I wonder if a screening process of the urinary tract would have to be considered in the future to prevent accepting inductees with these various anomalies and instances of symptomless pathology in the upper urinary tract.

MAJOR PRATHER:- Any further remarks on the last speakers?

MAJOR F. C. HAMM:- I would like to congratulate Major Leader on his simplification of the catheter-loop extractor. It is a very satisfactory instrument, and I have had considerable more success in using this type of extractor than with others I have tried. The removal of ureteral stones by manipulation is not a trivial procedure. The mortality associated with this procedure is perhaps equal to surgical removal of ureteral stones. Many of the instruments that have been devised for the extraction of the ureteral stone are made of metal, and there is some danger in perforating the ureter when metal instruments are used. So far, we have not found it necessary to dilate the ureteral orifice, and I do not believe it is advisable, except in rare instances, to cut the ureteral orifice. Serious sequelae may develop cutting the ureteral orifice. Ascending infection and ureteral stricture have been observed following this procedure. The catheter-loop appears to be relatively atraumatic and a very satisfactory method for abstracting low lying stones that are less than 1 cm. in diameter.

In discussing Captain Miller's paper, I have made it a practice not to do varicoceles unless they are very large, and obviously interfere with the patient's activity. I do not believe that we have done over eight or ten in over three years in the Army. Certain diseases seem to carry a certain mental fixation of symptoms, and varicocele appears to be one of these conditions. I do not believe that surgery on varicocele produces good results. It is important to prepare each patient before operation for hydrocele by telling him that he will have residual swelling and discomfort in the scrotum for several weeks following the operation. This swelling is due to edema and will gradually subside. Our results with hydrocele operation have been satisfactory.



MAJOR PRATHER:- Any further discussion? Any further remarks by Captain Miller before closing? We have one more formal paper on the program for the morning "Examination of Peripheral Neuromata for Immediate Determination of Adequacy of Incision" by Major William Antopol.

MAJOR WILLIAM ANTOPOL:- "To replace a carefully made nerve anastomosis into a bed of scar tissue has always been conceded to be undesirable." "It is important that the central stump of the severed nerve should be trimmed until normal appearing nerve bundles appear. Likewise the distal stump should be trimmed until well formed bundles of Schwann cell tubes are evident. There can be no compromise with these trimming procedures, for unless the anastomosis is made of tissue free of scar, the operation is ~~doomed to~~ failure." (R. Glen Spurling - Journal of Neurosurgery 1944: 1,123).

The need for immediate examination of peripheral neuromata at operation to determine whether excision is adequate has been frequently discussed with Major Barnes Woodhall and Major George Maltby but the problem was not attacked vigorously. Interest in this was revived after receiving communications from Major Barnes Woodhall, the Neurosurgical Consultant to the Surgeon General's Office:

"16 August 1944: We are becoming more and more impressed with the necessity of some type of pathologic check on our gross estimation of 'normality' of the sectioned stump. And the same idea has been mentioned time and time again by the English. I do hope that you can concentrate on it and get it perfected by the time our next large group of cases comes in."

#### METHOD

FIXATIVE: The fixative used is a 1 $\frac{1}{2}$ % acetic acid solution in formalin. This preserves both nerve structure and myelin. Tissues placed in this fixative still retain their tinctorial qualities after ten months.

STAINING SOLUTION (1): The stain proper has undergone frequent modification, and the present formula should not be considered final. The last modification consists of:

(1)- This stain, with various modifications using lead acetate, tannic acid, picric acid and thionine and other substances, was investigated in the laboratories of the Newark Beth Israel Hospital. These were used to stain the basement membranes of the renal tubules and glomerular tufts, the fibrillar reticulum of the liver and structures in the liver cells resembling bile capillaries.

Equal parts of a 2% solution of each of the following:

Pyrogalllic acid  
Acid Fuchsin  
Aniline Blue

WASH WATER: The frozen sections are placed in an approximately 1 $\frac{1}{2}$ % acetic acid in tap water. These sections can also be used for study with polarized light.

Cross sections are taken from both proximal and distal ends of the resected nerve immediately upon removal and boiled in the fixative. Frozen sections are made and kept in the wash water. The desired sections are floated on slides and a drop of the stain is applied to the flattened tissue for five seconds; the section is then washed and mounted on the slide in the acidified water and examined. Mounting in glycerin is unsatisfactory. The sections may be permanently preserved by dehydrating, passing thru carbol-xylol and zylol and mounting in balsam.

Myelin stains a brilliant red if the tissue is freshly fixed, otherwise it stains yellow. The axis cylinder stains blue. The collagen, however, also stains blue providing a distinct drawback. Work is in progress to eliminate this objection. The yellow staining myelin remains birefringent with polarized light studies.

The stain can also be used on paraffin sections. A fine network is observed in place of the red staining myelin.

### DISCUSSION

In the determination of adequacy of excision it is for the neurosurgeon and not the pathologist to decide whether sufficient tissue has been removed. Each case must be considered individually on the basis of anatomic and clinical findings utilizing the histology only as a guide. If sufficient proximal nerve remains, the neurosurgeon could demand that the proximal stump be free of even small amounts of endoneurial fibrosis. If there is but a few millimeters of remaining neural tissue which still can be removed, this can be examined consecutively millimeter by millimeter until the optimal proximal stump is reached. In these cases one must remain content with a nerve architecture which, in the former cases, would be considered unsatisfactory. Transition between comparatively normal nerve structure and the neuroma formation may be surprisingly abrupt and even in apparently hopeless cases serial thin segments should be removed and examined; at times, in one millimeter there may be a startling and contrasting mutation from a completely disorganized scar tissue to an entirely unsuspected relatively normal nerve architecture. The distal stump likewise must be located beyond the neuroma area and should have as normal an architectural arrangement of the bundles as is consistent with the amount of tissue as may be removed in the individual cases.

The significance of this procedure must await careful evaluation and correlation of the microscopic findings with ultimate clinical results in a large series of cases.

The author wishes to express his grateful appreciation to Miss Ellen Talbot for her able technical assistance, to Major George Maltby for his valuable aid and detailed observations, and for providing many of the specimens, to Lt. Colonel Barnes Woodhall for his interest, and to Lt. Colonel Stone, Lt. Colonel McCravey, Lt. Colonel Braden and Major Elkins for the patience and cooperation in the demonstrations at their respective hospitals.

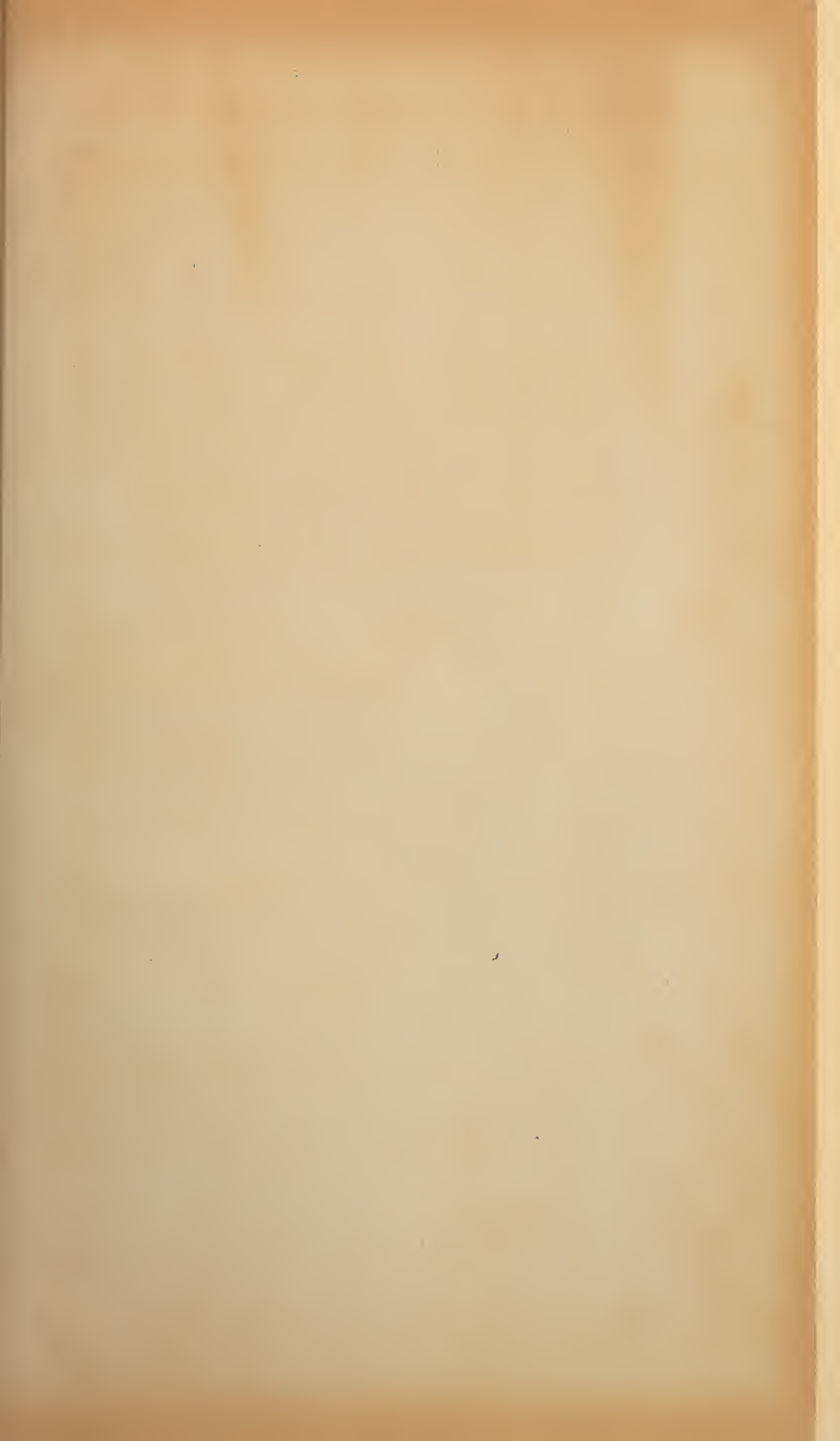
COLONEL C. S. BECK:- We are very grateful to Major Antopol for coming here and making this demonstration to us. His work is known in the neurological centers of the 5th Service Command and I thought that the other surgical consultants would like to see this technique. I might mention that Major Antopol received a letter of commendation for this work from the Surgeon General's Office.

LT. COLONEL FRANK MAYFIELD:- I am much impressed with the beauty of this stain and the fact that it can be done easily and quickly. The matter of doing adequate tissue study on nerves has been long and laborious and has been abandoned. I am skeptical of its value as an adjunct to the operating table. However, that is now being tested and will be proved or disproved. It should be a great contribution to the study, and I am very much pleased to have had the opportunity to see it.

MAJOR GEORGE MALTBY:- I have not had any experience with the use of this stain at the operating table. However, it will undoubtedly be a marked contribution to the handling of peripheral nerve lesions. The slides shown by Major Antopol show beautiful staining of the nerve bundles and axon cylinder. There is some question, however, about the actual practicability of this method at the operating table inasmuch as so frequently gross examination of the nerve showed it to be abnormal as far back as we dared cut it and get a satisfactory end-to-end suture.

MAJOR PRATHER:- As chairman of the meeting this morning, and as one of the many who are here on orders, I should like to express our enthusiasm and appreciation to Colonel Beck, who initiated this meeting, and to Colonel Noyes, who approved and ordered it. Likewise, the delightful hospitality we have enjoyed at this hospital is recognized and acknowledged by all of us. We wish to express similar thank to Colonel Cook, Colonel Peor, and the entire staff here at this hospital for this very fine scientific meeting and the fine visit we have had for the past two days. The meeting is now concluded.











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